The Introduction of GIS Technology in the State Parks - State of São Paulo: Constraints and Opportunities

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Declaration

I am responsible for composing this dissertation. It represents my own work and where the work of others has been used it is duly acknowledged.

Mônica Modesta Santos Decanini

People talk far too much. They always want to affix ready-made labels to their experiences. It is as though they were unable to enjoy the beauty of a flower until they had given it its correct botanical classification and a Latin name.

The Essence of Zen, by M. S. Sangharakshita

Dedicated to my parents,

aunts Luzia and Olésia,

to my cousin Leonardo (in memoriam),

to my brothers and sister,

to my nephews and niece,

and to Taninha

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Abstract

The Brazilian Atlantic Forest is one of the Earth's most endangered ecosystems. It has high biodiversity and a high level of plant and animal endemism. One of the largest remnants of that forest is located in the State of São Paulo. Most of the significant residual fragments of the State have been designated under various categories of conservation, the largest part of the area being composed of state parks. Information is recognised as a key tool for effective management of parks and protected areas and, therefore, for conservation. GIS is an information management tool which deals with spatial and non-spatial data, and it has been adopted by park organisations in the industrialised developed countries such as Canada and USA. Such information technology demands skilled human resources and budget commitment. However, the organisational and managerial context in tropical developing countries such as Brazil, is restricted by a shortage of adequate human resources and government funds for establishment and management, lack of continuity in policy and in support for parks and protected areas. Therefore, the adoption of GIS technology for the state parks in the State of São Paulo is likely to be constrained. However, the Appropriate Technology approach can offer a more comprehensive and adequate framework to deal with the issues of technology choice and implementation in circumstances where they are limited. Whist recognising the benefits of GIS, the precise context and timing of any possible installations demands more careful consideration than has been offered so far, either by the State of São Paulo or elsewhere in Brazil. A qualitative approach based on two case studies was adopted to collect and analyse data on issues of park organisation. The research findings suggest that human resource and government funding shortages are the critical issues. Some alternatives were identified, based on principles of Appropriate Technology. A start can be made using a PC mapping system such as a simple version of AutoCAD, which is now available in the park central agency. Furthermore the three State Universities could contribute in a more systematic manner in resource data collection and training. However, the inadequate salary policy, the lack of management and information plans, and administrative discontinuity may hinder the successful implementation and use of the spatial data handling system. A strong commitment to conservation issues is essential for the better management of parks and therefore for improved data management. Future research could profitably monitor the success of using AutoCAD or any other simpler automated data handling system before any more sophisticated method of GIS is adopted.

Acronyms

AIS- Aerial Information Systems

APA- Área de Proteção Ambiental

Environmental Protection Area

APqC- Associação de Pesquisadores Científicos do Estado de São Paulo

Association of Scientific Researchers of the State of São Paulo

ARIES- Áreas de Relevante Interesse Ecológico

Areas of Ecological Interest

ASPES- Áreas sob Proteção Especial

Areas under Special Protection

BANESER- Banespa Serviços Técnicos e Administrativos S/A

Banespa Technical and Administration Services

BANESPA- Banco do Estado de São Paulo

State Bank of São Paulo

CEAM- Coordenadoria de Educação Ambiental

Agency for Co-ordination of Environmental Education

CESP- Companhia Energética do Estado de São Paulo

Energy Company of the State of São Paulo

CETESB- Companhia de Tecnologia de Saneamento Ambiental

Environmental Sanitation Technology Company

CGG- Comissão Geográfica e Geológica

Geographical and Geological Commission

CINP- Coordenadoria de Informações Técnicas, Documentação e Pesquisa Ambiental

Agency for Co-ordination of Technical Information, Documentation and Environmental Research

CLT- Consolidação das Leis Trabalhistas

Consolidation of Labour Laws

CODEL- Comite de Defesa do Litoral

Committee for Coastal Defence

CODESPAR- Conselho para o Desenvolvimento do Pontal do Paranapanema

Council for the Development of the Pontal do Paranapema

CONSEMA- Conselho Estadual do Meio Ambiente

State Environment Council

CPLA- Coordenadoria de Planejamento Ambiental

Agency for Co-ordination of Environmental Planning

CPRN- Cordenadoria de Proteção de Recursos Naturais

Co-ordination Agency of Natural Resources Protection

DEPAN- Departamento Estadual de Parques e Áreas Naturais

State Department of Parks and Natural Areas

DFEE- Divisão de Florestas e Estações Experimentais

Division of Forestry and Experimental Stations

DEPRN- Departamento Estadual de Proteção dos Recursos Naturais

State Department for Protection of Natural Resources

BNDE- Banco Nacional do Desenvolvimento

National Bank for Development

DPP- Departamento de Projetos e Paisagens

Department of Projects and Landscapes

DRPE- Divisão de Reservas e Parques Estaduais

Division of State Reserves and Parks

DSG- Diretoria de Serviço Geográfico do Ministério do Exército

Directorate of Geographical Services for the Army Ministry

E.EC- Estação Ecológica

Ecological Station

ESRI- Environmental Systems Research Institute

P.E.- Parque Estadual

State Park

R.E.- Reserva Estadual

State Reserve

FBCN- Fundação Brasileira para Conservação da Natureza

Brazilian Foundation for Nature Conservation

FF- Fundação para a Conservação e Produção Florestal do Estado de São Paulo

Foundation for Conservation and Forestry Production of the State of São Paulo

FUNDAP- Fundação de Amparo a Pesquisa

Foundation for Supporting Research

FUNCATE- Fundação de Ciências, Aplicações e Tecnológias Espaciais

Foundation of Sciences, Applications and Space Technology

FWS-US- Fisheries Wildlife Service (Department of Interior-US)

IAC- Instituto Agronômico de Campinas

Agricultural Institute of Campinas

IBAMA- Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis

Brazilian Institute for Environment and Renewable Natural Resources

IBDF- Instituto Brasileiro para o Desenvolvimento Florestal

Brazilian Institute for Forestry Development

IBGE- Instituto Brasileiro de Geografia e Estatística

Brazilian Institute of Geography and Statistics

IBt- Instituto de Botânica

Botanic Institute

IF-Instituto Florestal

Forestry Institute

IG- Instituto Geológico

Geological Institute

INCRA- Instituto Nacional de Colonização e Reforma Agrária

National Institute of Colonization and Land Reform

INPE- Instituto de Pesquisas Espaciais

Institute of Space Research

IPE- Instituto de Projetos e Pesquisas Ecológicas

Institute of Projects and Ecological Research

ITESP- Instituto de Terras do Estado de São Paulo

Land Institute of the State of São Paulo

IUCN- International Union for Conservation of Nature and Natural Resources

JICA- Japanese International Co-operation Agency

KfW- Kreditanstalt fur Wiederaufdau (Instituição de Crédito para Reconstrução)

Credit Agency for Reconstruction

US NPS- US National Park Service

NCGIA- The National Centre for Geographic Information and Analysis

PECJ- Parque Estadual de Campos do Jordão

State Park of Campos do Jordão

PEMD- Parque Estadual do Morro do Diabo

State Park of Morro do Diabo

PETAR- Parque Estadual Turístico do Alto do Ribeira

State Tourist Park of the Alto do Ribeira

PNMA- Programa Nacional do Meio Ambiente

National Programme of Environment

PqC- Pesquisadores Científicos do Estado de São Paulo

Scientific Researchers of the State of São Paulo

SAA- Secretaria da Agricultura e Abastecimento

Secretary of Agriculture and Food

SEMA- Secretaria do Meio Ambiente (Federal)

Secretary of the Environment

SMA- Secretaria Estadual do Meio Ambiente

State Secretary of the Environment

SEPLAM-PR- Secretaria de Planejamento da Presidência da República

Secretary of Planning of the Presidency of the Republic

SUDEPE- Superintendência do Desenvolvimento da Pesca

Agency for Fishing Development

SUDHEVEA- Superintêndencia da Borracha

Agency for Rubber

UCs- Unidades de Conservação

Conservation Units

UNICAMP- Universidade de Campinas

University of Campinas

UNEP- United Nations Environment Programme

UNESP- Universidade Estadual Paulista

Paulista State University

USP- Universidade de São Paulo

University of São Paulo

WB- World Bank

WWF- World Wildlife Fund

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CHAPTER 1

Introduction

1.1 - Context of the Problem

The Brazilian Atlantic Forest, located along the eastern coast of Brazil, once occupied one million square kilometers with a width varying from 80 to 120 km inland from the coast (Andrade-Lima, 1977). It occupied 12% of the country's total land area of 8,511.956 km^2 (Brandão, 1990). Exploitation of various timbers, cutting for firewood, charcoal, forest replacement with sugar cane, coffee, cocoa plantations, and cattle ranching has reduced the Atlantic Forest to a small remnant of its former extent (Mori et al., 1981). At present, the remains of the Atlantic Forest represent about 5-6% of the original cover (IUCN, 1988, in Brandão, 1990). Figure 1.1 presents the past and actual distribution of Atlantic Forest and shows a clear picture of forest destruction.

The Atlantic Forest is one of the Earth's most endangered ecosystems. It possesses a remarkably high biodiversity and a high level of plant and animal endemism. For example, about 53% of the tree species are restricted to this ecosystem (Mori, 1989). The level of endemism is generally high for reptiles, birds and especially primates (Fonseca, 1985). Of 220 species of endangered vertebrates, 171 live in the Atlantic Forest (SMA, 1993). According to the Brazilian Society of Zoology (*Sociedade Brasileira de Zoologia*) there are probably seven vertebrates species already extinct in Brazil, six of which are from the Atlantic Forest (see Munhoz, 1992).

Historically, the southeast of Brazil has been heavily colonised. Currently it is the most densely populated and industrialised part of the country. About 78% of Brazil's total population resides in States that contain the remnants of Atlantic Forest.

Figure 1.1 - The present and original distribution of Atlantic Forest in Brazil.

Source: Guillaumon et al., 1989, p. 37

About 30% of the population lives in the two States of São Paulo and Rio de Janeiro (Brandão, 1990). One of the largest remnants of Atlantic Forest is located in the State of São Paulo (Figures 1.1 and 1.2). These facts give some indication of the pressure upon the remnant Atlantic Forest ecosystems in these two States.

Conservation of the remnant areas of Atlantic Forest relies upon maintaining them as functioning ecosystems. Conservation of these ecosystems would contribute to the preservation of a gene pool important for pharmacology and agriculture (IUCN, 1980). One of the approaches that has been adopted all over the world for conserving biodiversity is the establishment of land management categories for protection (IUCN, 1984; IBDF, 1982; IUCN, 1986; IPT, 1988). Because of the historical development pressures in coastal Brazil, and in the State of São Paulo in particular, the designation of conservation areas is important for the survival of the remaining Atlantic Forest.

Most of the significant remnants of Atlantic Forest domain in the State of São Paulo have been designated under various categories of conservation management such as state parks, biological reserves or ecological stations[1]. The State of São Paulo also has a large proportion of highly degraded landscape which urgently needs to be regenerated. The state parks and other protected areas are the last places in the State available to serve as a baseline for conservation management and possible regeneration of the surrounding landscape. State Parks have as primary objectives the conservation of the biological diversity, to protect the species threatened by extinction; and to provide and manage recreation and tourism services (IPT, 1988).

[1] State parks, reserves and ecological stations are protected lands that must be legally owned and administered by the state government agency (Pagani, 1995). The agency in charge of the state parks is the DRPE-IF an agency subordinate to the SMA. According to the State Law n. 6884/62, state parks are areas owned by the state government, which are set aside for conservation and protection of landscape, flora and fauna; only 1% of the area can be used for constructing restaurants, museums and the like (IPT, 1988). The Federal Law n. 4771/65 (Article/Item 5. of Forestry Code) prohibits the exploitation of the natural resources within parks (see IPT, 1988). The category state parks is regulated by the State Decree 25341 - 04/06/86 (São Paulo, 1986).

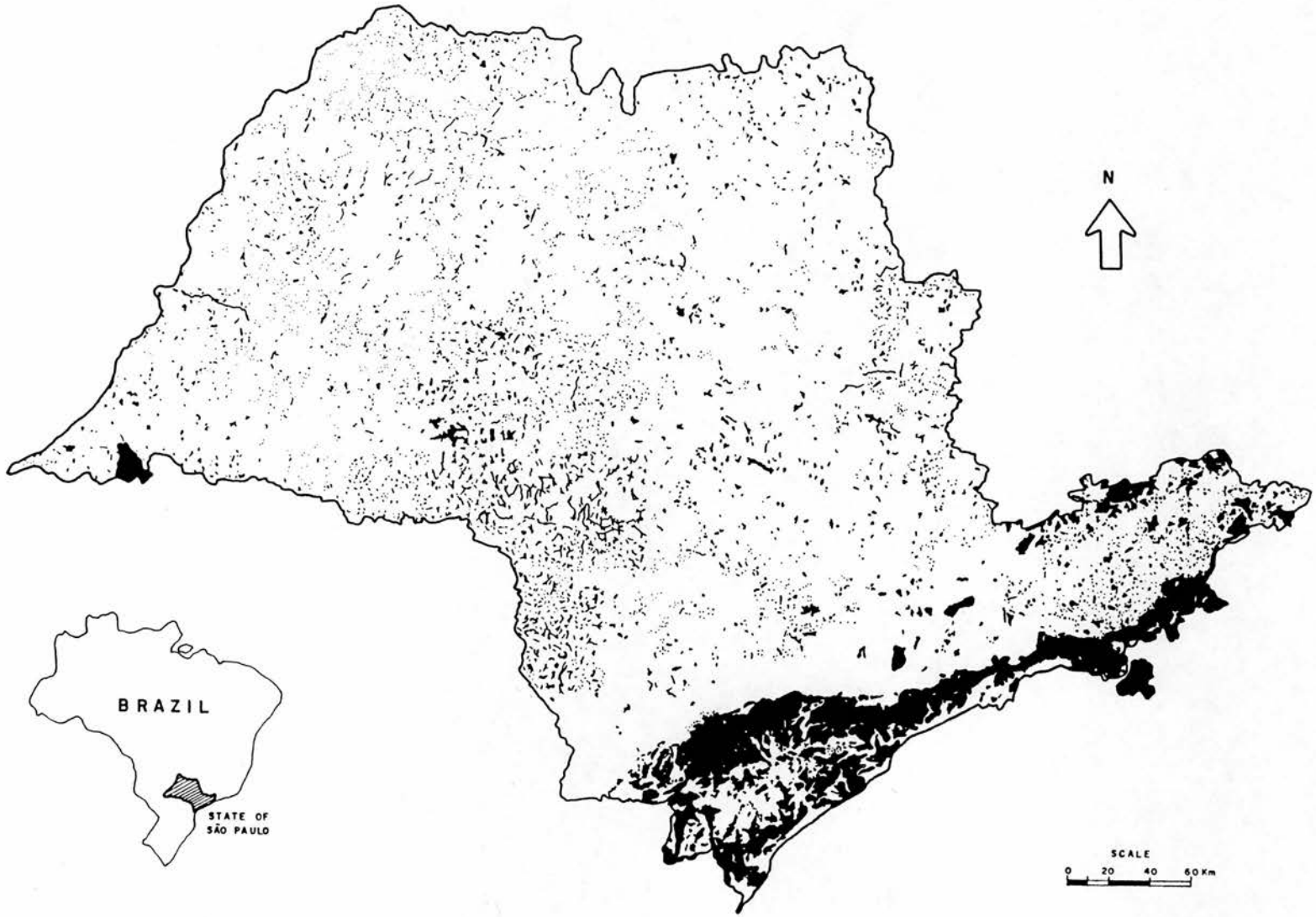

Figure 1.2 - The remnants of natural vegetation in the State of São Paulo.
Source: Kronca et al., 1993

They therefore have a substantial function as ecological research sites, and an important role in the conservation of the State's landscape. A number of studies have presented in detail the critical reduction of the natural vegetation and fauna of the State of São Paulo. Victor (1975) produced a seminal work which evaluated the process of deforestation in the State since the last century when the coffee economy started to grow (Figure 1.3). He found that by the mid-19th Century the natural vegetation cover was about 81.2% of the land area of the State, and estimated that only 3% of the natural forest would be preserved by the year 2000, and this would mainly coincide with the land now designated as parks, reserves and ecological stations.

Between 1988 and 1989, the Office of the State Secretariat of the Environment of the State of São Paulo (SMA), undertook an inventory of the natural vegetation of the entire State. This inventory revealed that remnant natural forest covered about 7.6% of the land area of the state. The comparison of the last two natural vegetation inventories shows that deforestation was still evident over the two last decades (Table 1.1).

Table 1.1- Deforestation between 1973 and 1990

Year	1973 [1]		1990 [2]	
Categories	Area (ha)	%	Area (ha)	%
Mata (forest)	2,069,920	8.33	1,846,966	7.58
Capoeira (cleared land)	1,241,090	4.99	983,914	4.04
Cerrado (shrub savanna)	105,390	0.42	3,175	0.30
Cerradão (savanna woodland)	784,990	3.16	208,647	0.86
Campo Cerrado (grass and shrubs)	148,990	0.60	1,883	0.01
Campo (grassy savanna)	43,870	0.10	1,933	0.01
Total	4,394,250	17.68	3,116,518	12.80

Source: [1] Serra Filho et al., 1974, and [2] DEPRN-FUNCATE-IF-FF, 1991 (both in Castanho Filho and Macedo, 1991).

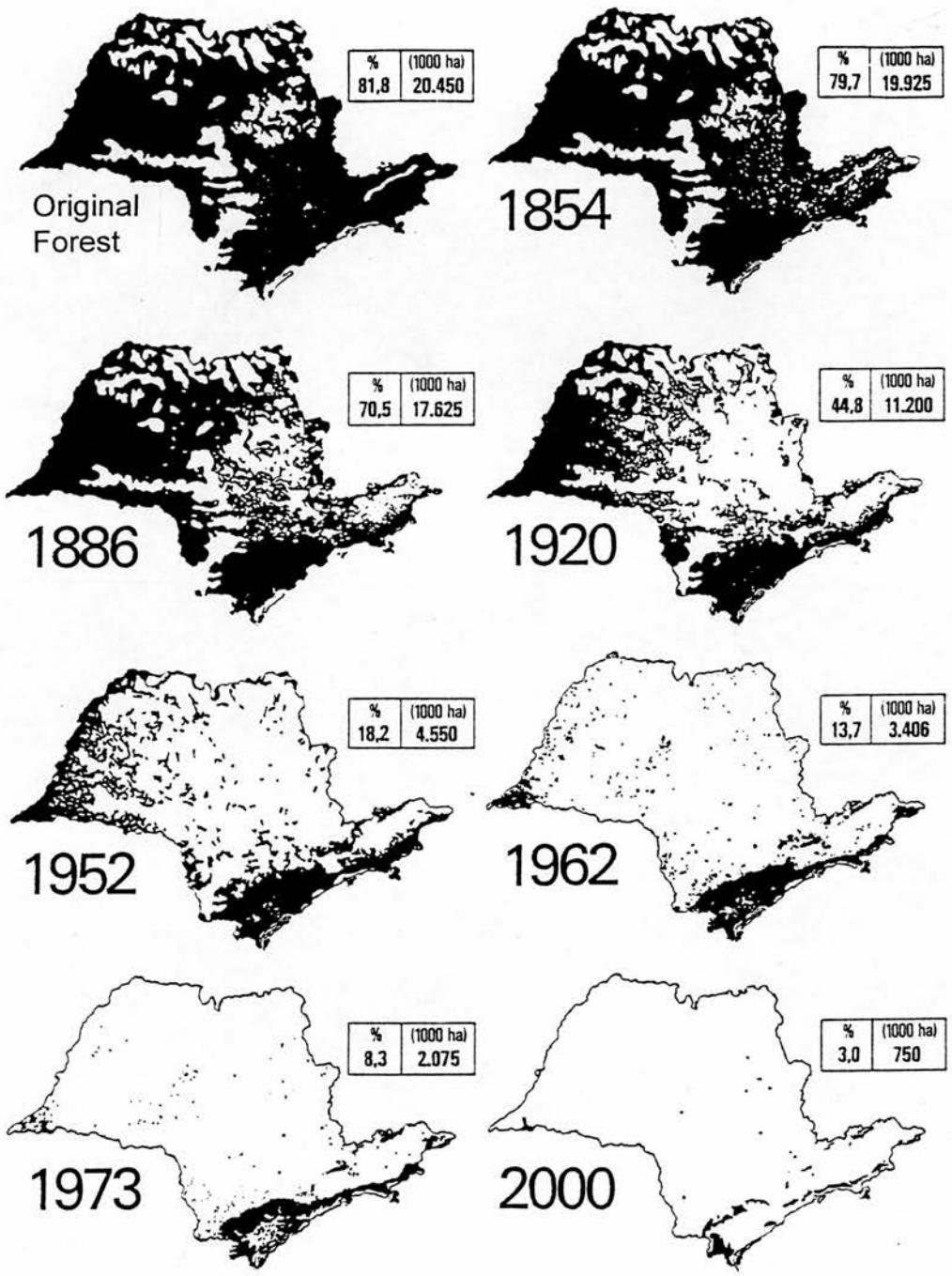

Figure 1.3 - Progressive deforestation in the State of São Paulo. Area of forest cover and its percentage are given in the boxes.
Source: Victor, 1975

The west region is the most heavily disturbed area of the State, with few residual fragments of natural vegetation; it has a very degraded landscape suffering soil erosion and silting of rivers. The most important fragment of natural vegetation in this region is the State Park of Morro do Diabo. Currently, the largest remnants of Atlantic Forest are found in the Ribeira Valley and the Coastal region where 67.8% of the natural vegetation remains (Castanho Filho and Macedo, 1991) (see Figure 1.4). This region is where most protected areas have been designated. The natural vegetation has been preserved within this area partially because colonisation and the expansion of coffee plantations found natural obstacles in the mountain slopes of the Serra do Mar, and in the subtropical climate of the south. However, over the last 20 years there has been growing pressure to develop this region through land speculation for tourism, illegal mining and timber extraction.

The coffee based economy and the following industrial development of the State have deeply affected the pattern of the remaining natural resources. The development process brought about deforestation, accelerated soil degradation, air and water pollution, and the construction of numerous hydroelectric power plants to supply the needs of industrialisation and increasing population. Therefore, the designation of the Atlantic Forest remnants under conservation management categories is an important step towards their protection. Even so, it is not sufficient. The survival of these areas will depend upon sound management which demands resource information.

1.2- The Need for Information and the Problems of Introducing GIS Technology

Humid tropical forests contain the majority of the biological resources of the planet. It is believed that the rate of species extinction in the tropical areas is very high, although current knowledge of species and ecosystem

West Paulista Region (820,488.16 ha = 5.82%)

Central Region (1,400,891.96 ha = 16.20%)

Coastal and Vale do Ribeira Region (1,115,377.67 ha = 67.67%)

Figure 1.4 - Percentage of natural vegetation remnant in the State of São Paulo by regions defined by Project 'Olho Verde'.

Source: Surpresa Via Satélite/*JournalECO* (1991).

functioning is inadequate (McNeely et al., 1990). Because of the climatic conditions (such as much heavier rainfall; more fragile soils; greater insolation rendering vegetation more susceptible to wildfires), tropical forest ecosystems are much more liable to degradation than temperate ecosystems (IUCN, 1986). Information is acknowledged as a key tool for the effective management of parks and protected areas, and therefore for the conservation of biodiversity (IUCN, 1986; IUCN, 1993). It can serve to reduce uncertainty in the management of parks by generating answers to conservation problems, such as those related to the risk of species extinction. For instance, are the numbers of individuals of any species declining? If so, do we know why? Changes in the distribution and abundance of species are extremely important for management, requiring measurement of similar samples over time (IUCN, 1986). Therefore, information, both quantitative and qualitative, is an essential tool to study and monitor natural resource condition and uses in order to develop and revise plans and strategies. In parks within the State of São Paulo there are management problems such as the restoration of habitats, burning (notably worse in the drier regions of the state); management of wildlife, management of small populations of endangered species and visitor management. The management of all these activities requires adequate information.

Therefore, one of the management needs of parks is the development of an information management system. The aim of such a system is to promote the supply of adequate and sufficient data for the required analysis. This information management system should aim to identify the best means of analysing and presenting information for research, management, education and communication (e.g. to schools and the media).

Ecological monitoring is one of the most important tasks for both conservation managers and researchers because it can enable them to understand ecosystem dynamics. Ecological inventory is the standard method to gather the baseline information to assess the state of the protected area in future. One of the

important requirements for an ecological monitoring system is to have the data tied to a standard reference grid (e.g.: UTM) in the protected areas which will make repeated observations very easy to compare, and provide the basis for a system of long-term monitoring (Gwynne and Croze, 1979).

Spatial information is required to identify the distribution of 'what, where and how much' of natural resources (e.g., vegetation type, soil characteristics, topography, geomorphology, drainage systems) and their inter-relationships. The Geographical Information System, or GIS, is one means of information management which deals with spatial information. GIS has proven capabilities for integrating spatial and non-spatial data, and for bringing together disparate and large datasets within a common spatial framework in a digital form (Pohchin, 1992). These systems can quickly generate and update maps, calculate areas, produce overlay analysis, generate elevation models, and provide databases for simulation and predictive models which can be useful for conservation managers and researchers. GIS has a great potential for the organisation and co-ordination of research in parks. As Scarpace et al. (1990) note, it could help to relate separate research information by retrieving data about any particular site, which could be used for comparative studies. The geographic database is an important asset for conservation management.

The Congress of Parks and Protected Areas, held in Venezuela in 1992, emphasized the need of improving the means of data collection and data management to *"foster improved information management at the site level, through strategies for information handling and exchange"* (IUCN, 1993, p. 43). The main thrust of the present thesis is the recognition that advances made in data management technology can improve data access and manipulation, and thus provide a more integrated view of the environment. GIS is an information management tool which deals with spatial and non-spatial data, and it has been adopted by park organisations in developed countries, such as Canada and USA, for more than ten years. However, the organisational context of parks in tropical developing countries seems to be more

limited. According to IUCN (1986) parks within these countries are generally under-resourced for the implementation of management recommendations and have to face uncertainty in management due to current limited knowledge of complex tropical ecosystems. The *"I Seminário sobre Banco de Dados para Conservação no Brasil"* held in 1989 (Fundação SOS Mata Atlântica, 1990) pointed out some of the problems of the lack of basic biological data for conservation in Brazil, the lack of expertise to collect these data, and the need to improve the flow of research data for conservation management. The adoption of a GIS based information management system has to be considered against the backdrop of these constraints.

The introduction of information technology is not a straightforward technical exercise, but it is an organisational development which requires support structures, stable finances and trained personnel. Therefore it is subject to institutional and organisational constraints. Masine (1990) stresses that the lack of adequate resources, particularly human resources, constitutes a great impediment to the implementation of information technology in the organisational environment of developing countries. Recent studies have focused on the institutional aspects of the implementation of GIS in developing countries (Al-Ankary, 1991; Fox, 1991; Meijer and Kuipers, 1992). Furthermore, several authors include concepts of Appropriate Technology in the geo-information technology field. Meijer and Kuipers (1992) and Yapa (1991), for instance, have emphasized low-end and low-cost GIS technology alternatives, arguing that they are simpler, easier to apply and readily available in developing countries (discussed in Chapter 3). However, the choice and acquisition of technology is only one aspect of the problem of introducing technology into the conservation management process. Despite the continuing reduction in price of GIS and data management technology, the costs of system operation and database maintenance within the envisaged organisation still remains a major obstacle. Furthermore, skilled staff are essential for the successful use of a GIS.

The success of a GIS project will be heavily affected by the local institutional capacity. The State of São Paulo has the second largest public budget after the national budget, yet the state park system seems to face similar problems of those of the national parks[2]. Therefore, the adoption of a GIS technology for the state parks in the State of São Paulo is likely to be constrained by lack of adequate human and financial resources. Thus, the adoption of this technology in state parks in São Paulo cannot be modeled simplistically on the experience of affluent temperate countries. Local alternatives for data management need to be explored.

1.3 - Objectives

This thesis will address the current capacity of the State of São Paulo legislature to adopt a comprehensive information system, specifically on-site GIS technology, for the management of its parks. Whilst recognising the benefits of GIS and its related technologies, the precise context and timing of any possible installations demands more careful consideration. In considering this argument, three specific objectives are proposed:-

- to examine information management issues in the state parks;
- to identify and analyse the organisational and institutional factors which may influence the effective use of information and GIS technology in the context of government parks;
- to identify and examine some of alternatives to the adoption of a comprehensive technology, which may prove more appropriate to the data management needs of parks, given their local organisational and institutional constraints.

[2] For the national parks problems (lack of human resources, lack of adequate budget and unsolved land tenure) see Redclift (1987) and CIMA (1991).

These objectives are addressed in the following chapters.

Chapter two examines parks in the perspective of a systems approach to management. It also examines the potential information needs and data problems in tropical countries.

Chapter three discusses the role of GIS for conservation managers, the reasons for its success in developed countries such as Canada and USA, and discusses the problems in introducing GIS in developing countries. It evaluates the introduction of GIS technology in the context of limited resources and in the light of the appropriate technology principle.

Chapter four presents the fieldwork and data collection methodology with an emphasis on a qualitative research approach.

Chapter five analyses the general organisational structure and institutional characteristics of parks in the State of São Paulo, and funding issues for their conservation management.

Chapters six and seven assess the organisational and institutional context of two specific parks: State Park of Morro do Diabo and State Park of Campos do Jordão, as examples of the situation within São Paulo.

Chapter eight presents the conclusion of this study, examining the organisational and institutional constraints to the implementation of GIS technology for the management of state parks, and suggesting alternative solutions.

CHAPTER 2

Park Ecosystems and information management issues

2.1- Introduction

This chapter examines the role of parks in conservation and regional development. It also analyses parks from the perspective of a systems approach to management. The park system is interconnected with the broad biological and social environment and therefore it can be modified and influenced by human actions from inside and outside. Thus, park management demands information to evaluate the status of its biological environment in order to achieve conservation objectives. Information management issues will be discussed in this context.

2.2- The contribution of parks to conservation and development: an overview

Biodiversity, defined as the total of genes, species and ecosystems, has been depleted by human exploitation, particularly since the industrial revolution (McNeely et al., 1990). Local ecosystems were transformed into food production areas using pesticides, fertilisers and heavy machinery (McNeely, 1984). The development philosophy of economic growth promoted the over-use of natural resources and caused environmental destruction such as deforestation, biomass loss, water pollution and soil erosion. As a result, non-governmental organisations such as IUCN have attempted to promote conservation concepts through the establishment of national parks in order to ensure the survival of natural ecosystems.

The Convention on Nature Protection in the Western Hemisphere approved in 1940 was considered an important step that helped to encourage the establishment of the parks and protected areas, as well as to increase the number of different categories of management (McFarland et al., 1984). By 1962, IUCN sponsored the first Conference on National Parks, which prepared the foundations for expansion

(McNeely, 1984). IUCN played an important role in the establishment of parks and protected areas at an international level.

The growing international environmental concern also contributed to the expansion and pressures for improvement of parks and protected areas in the World. From 1979 to 1980 the growth of national parks reached about twice the area that existed in 1969 (Harrison et al., 1984).

Nevertheless, parks should not be seen as isolated areas since they have linkages with the external environment (e.g., biophysical and social) and as Clark (1986) notes, they must constitute a form of land use that is complementary. Many authors stress the important role of parks in maintaining the balance between conservation and development. Lucas (1990) emphasises that the key contribution of parks to sustainable development is the conservation of living resources and the maintenance of biodiversity. Clark (1986) argues that parks can bring valuable benefits to regional development in the tropical developing countries. These include stabilisation of hydrological functions; protection of soils (tropical soils degrade quickly); stabilisation of climate (keeping down ambient temperatures with benefits for surrounding areas for agriculture and for human comfort); protection of genetic resources (most improvements in tropical agriculture and silviculture depend on their preservation); preservation of breeding stock; provision of recreational facilities; provision for environmental education; and provision of research and monitoring facilities (applied research still needs to be done in natural tropical ecosystems to find the factors that influence the stability and high productivity of poor soils). However, Lucas (1990) argues that parks can only achieve their full potential provided they are effectively managed. This will demand skilled personnel and adequate tools, such as information and monitoring of natural resources and their uses, to ensure that parks can fulfil their role.

2.3- A system approach for park management

Parks are institutions that were created to conserve, study, protect and manage biodiversity. However, it has been recognised that park environments have been increasingly affected by numerous human activities (Nelson et al., 1978; Dourojeanni, 1984). These activities involve resource exploitation (forestry extraction and mining); hunting; fishing; pollution; tourism; ranching; and construction of hydraulic infrastructure and highways (Dourojeanni, 1984; Jefferies, 1982). Therefore, the existence of a legal boundary plotted on a map does not mean that the human and physical linkages between the park and the outside environment are severed. A park is not a single entity but it involves interconnected components which make it a system that is related to the landscape and society which include and support it (Hart, 1966). Therefore, parks are also subject to outside influences, for instance the park system is influenced by human actions which can affect the biology.

Tchnell et al. (1983) and Machlis and Neumann (1987) argue that parks can be examined by treating them as ecological systems. The park ecosystem is formed by various interdependent subsystems: the biophysical environment (air, water, vegetation, wildlife and so on), the social environment (management institutions, cultural norms, rules and regulations and so on), and the human populations (visitors and local inhabitants) (Machlis and Tchnell, 1985) (see Figure 2.1). This park system is in turn embedded in a wider regional ecosystem and is influenced by the population, organisation, technology, and environment that is part of that region and therefore interacts with the park, for example, regional technologies such as industrial plants, agriculture and transportation systems may affect the park ecosystem (Machlis and Tchnell, 1985). Examples of these interactions are the impacts on the resources from surrounding land use practices, such as industry, tourism, agriculture, and ranching. These can contribute to chemical pollution and siltation of the water subsystem; loss of vegetation cover, fire, the introduction of exotic plants and species extinction in the subsystem vegetation; animal diseases, introduction of non-native animals, reduced

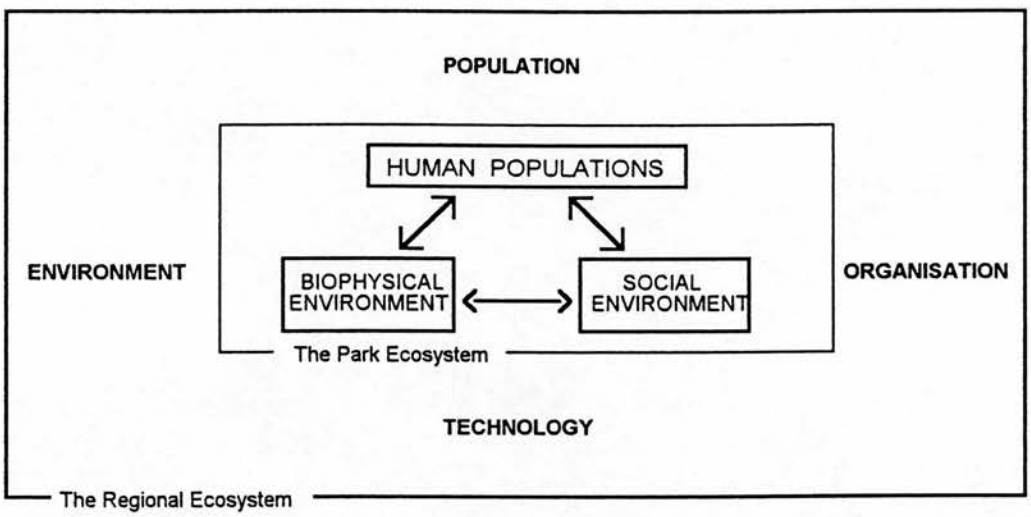

Figure 2.1- The conceptual diagram of the park ecosystem and its regional links. Source: Machlis and Tchnell, 1985

population of a species, species extinction, and overpopulation of species in the subsystem animals. These problems were reported by Machlis and Neumann (1987) in their study on threats to the parks of neotropics.

The biophysical environment comprises the natural resources of the park and the ecological processes (such as succession and nutrient cycling) necessary to sustain them (Machlis and Tchnell, 1985). This biophysical environment can be modified drastically by human disturbance. Therefore, management of a park system requires input of information about natural resources, ecological processes and human impacts. This information is a tool which helps to assess the state of the biophysical environment, and to support management, interpretation and research programmes. This should be one of the basic principles for sound management of a park ecosystem.

2.4- The park information requirements

It is widely accepted that management of parks requires an intervention approach, given the human influences inside and outside, even in the most remote areas (Curry-Lindahl, 1972; Hendee et al., 1978; Croze, 1984; IUCN, 1993). In the face of human actions and disturbance, management becomes an essential tool and research a means of improving the knowledge and information to support decisions of park and natural resource managers. Judgement based on background experience ('rule of thumb') is an important part of management of parks, but management also needs to be based on systematically collected information. The application of a scientific approach to the planning and management of parks was recommended in the early 1960's by the Commission on National Parks, during the First World Conference on National Parks (Van Osten, 1972). By the mid 1970's, Brazil had launched a National Plan for Protected Areas System (IBDF, 1979; 1982) that emphasised the need of scientific and ecological considerations for the establishment of protected areas and for management. The creation of parks used to be mainly based on landscape beauty rather than in a technical-scientific criteria (Pádua and Quintão,

1984). Yet, some Brazilian parks were created quickly just to save the natural resources from the rapid destruction (Gouvea, 1985).

However, the management of parks will not be effective without understanding how the park system functions in terms of biophysical resources, uses and their interaction. Information about resource conditions is essential to the management process. Park management also involves monitoring resource uses and ecological processes, in order to meet the objectives of protection and securing the resources and to provide recreational, scientific, educational uses on a sustained basis.

2.4.1- The Need for Resource Information

What has been argued so far and which has wide acceptance, is that the management of parks requires an understanding of what is occurring both inside and outside the boundaries, and consequently demands a sound information base to provide an inventory of resources and as a basis for monitoring. It is clear that gathering and presentation of information is a crucial step for effective planning and management. Davis et al. (1990) point out that by employing an information system approach, data can be used more effectively and better management strategies can be formulated.

The main aim of the park is to maintain and protect the ecological diversity, which includes the maintenance, regeneration and where possible improvement, of the ecosystem. It can be achieved by using management techniques that can involve the use and control of fire, the control or maintenance of species that are either over-abundant or at risk of extinction. It requires gathering data by means of surveys and continuous monitoring in order to answer questions such as for example, what are there? how many or how much? where? what will happen if? It may be seen that ecosystem components have a spatial and dynamic nature. Some of these components are more seasonal (time and space) such as rainfall, insolation, plant productivity (biomass and energy content), fire, distribution of migratory species whilst others are

more static such as topography, drainage and soils (Gwynne and Croze, 1976). These characteristics will determine the frequency, coverage and methods of data collection.

Thus, the management of parks involves monitoring of the ecosystem elements such as wildlife and livestock numbers, their distribution, population dynamics and habitat utilisation; vegetation, water, soil, flora dynamic; climate (rainfall, temperature, etc.) and fire. It also requires the development of ecological research to provide data about natural resources for restoration and maintenance of the ecosystems.

To Curry-Lindahl (1972), ecological research is a necessary basis for wise management and utilisation of resources, mainly to the management of parks, where it becomes a prerequisite for action. Indeed, information on resource conditions and dynamics is essential to the management process, in order to ensure use on a sustained basis and, thus protect the area. Resource information has been recognised as the key factor in formulating decisions which aim to achieve balance between conservation and development and therefore for supporting conservation management (Hendee et al, 1978; Backus, 1990; Davis et al, 1990; Lino, 1990; Nelson, 1991; IUCN, 1993). Wendt (1990) stresses the importance of using scientific information for protected areas management. The information, quantitative and qualitative descriptions, is an essential tool to develop and revise plans and strategies, to study and monitor natural resources conditions, ecological processes and uses. Information should contribute to the achievement of the objectives of parks formation and of conservation management for which both ecological and human research are required.

Wherever parks are located in the World, the basic major needs in resources research entail studies on the ecological components and ecosystem processes (soil, vegetation, water, wildlife and the relationships between them) (Hendee et al, 1978). Those studies can be developed to monitor the natural resources, to expand basic ecological knowledge, and to solve resources problems.

The principles of ecosystem management can enable the reintroduction of species, where ecosystem restoration is needed (Simmons, 1974). Of particular importance for management is an understanding of the role and the effects of fire. Such information is crucial for either developing prescribed natural fire or prescribed burn programs, or for maintaining fire suppression and fire prevention programs, for removing exotic plants and for restoration programs. Therefore, data collection on the location, extent and frequency of burning are necessary for both natural and man-made fire. This lends support to the development of a spatial database design. Satellite images, such as Landsat, illustrate a method that can be used to map burned areas (Grimsdell, 1977).

In São Paulo State, one of the most degraded and developed areas of Brazil, conservation research is crucial for the restoration of a very damaged landscape. The State Park of Morro do Diabo is the only significant remnant of natural forest in the west of São Paulo State. Therefore, it is vital to recognise and effectively use parks as research sites, which in São Paulo State are nearly the last significant places available to be used as a baseline for the surrounding landscape. This can provide a means for regeneration of degraded areas in situ and ex situ, such as the gallery forest and contribute to conservation management.

The management and assessment of the wildlife environment involves basic research on ecological factors to obtain descriptive data, such as distribution, numbers and population dynamics. Studies to establish baselines of natural conditions are required in order to provide a mean of comparison to judge the state of protected area in future, to investigate to which extent is being maintained, and the human influence inside and from outside (Hendee et al., 1978; Croze, 1984). There is a need for systematic observations of resource conditions to assess whether the situation is improving or deteriorating. This type of question requires monitoring using techniques such as air photography and satellite image analysis; meteorological and

hydrological analysis; radio tracking; and ecological ground surveys to study the plant and animal communities.

However, as DesMeules (1976) states the park inventory and studies should not be limited to present conditions but it should, where possible, include past conditions and attempt to anticipate future conditions; in other words to allow predictions. If measurements are taken on a continuous basis, it is possible to compare the situation in different times and places. In developing an informed management strategy for the Sunshine area in the Canada's Banff National Park, Price (1983) suggests that vegetation monitoring, by air photography and ground-level techniques, should take place every five years, and in case of major changes this interval can decrease. The main tool developed for that area management was a 1: 10000 map of vegetation type and of geomorphologic features that are used for trail planning.

This monitoring process will allow the detection of changes and trends and thus aid management action and control. Ecological monitoring is therefore a means of giving information on undesirable trends and indicating their causes (Grimsdell, 1977). Of importance for the monitoring process is the standardisation of methods for data collection and the classification system adopted, otherwise data cannot be compared.

Techniques for ecological data collection

The collection of ecological data can be from the ground and the air and will depend on the purpose, cost and physical characteristics of the area. The known aerial techniques are air photographs (conventional and Small Format Camera), visible spectrum satellite imagery (Landsat and SPOT). Ground ecological field surveys are other important tools for data collection.

The ground sampling survey is adopted to collect ecological data at more detailed levels of resolution than is available from air photographic methods. The data are recorded at sample points and can include, for instance, phytosociological

parameters (height, species and species density). These data can be collected by using sampling strategy techniques such as Point-Centred Quarter (Gwynne and Croze, 1976). The ground survey can also be used as a ground truth as it provides a means to assess the accuracy of identification of the features on the remote imagery (such as, for example, the mapping of vegetation types) (Price, 1983) .

Data collection from aerial photographs is widely accepted as being both necessary and at an appropriate resolution for the large amounts of data from areas the size of parks (Gwynne and Croze, 1979). It can be used for ecological data collection such as landscape classification, habitat information and drainage patterns.

Conventional air photography is the best known tool for mapping land resources, giving a high level of detail and accuracy. However, the elevated operational cost, particularly for monitoring, requiring further flights, limits its use for many studies in ecology and forestry, specifically in the mapping of small areas. Medeiros and Batista (1984) note that conventional vertical air photographic survey techniques present, in general, higher data quality than is required in many studies involving the characterisation of vegetation cover, ecological surveys or the detection of diseases in forests.

The use of Small Format Cameras (SFC) is an alternative of lower cost, being easy to use and efficient (Medeiros and Batista, 1984; Warner, 1989). SFC can be used for map revision and thematic studies such as ecological mapping (Watson, 1983). It can be particularly useful for monitoring change in natural vegetation and regeneration at appropriate scales. Thus SFC could be a viable alternative to more sophisticated technique with low operational costs and flexible use (Medeiros and Batista, 1984; Disperati, 1991). Among the uses of a SFC that may be relevant for park management are examining the impacts of trails, studying vegetation regeneration, monitoring ecological boundaries and fire incidence, habitat information, identifying erosion and landslide, counting animals and sickness detection (Disperati, 1991).

The other major aerial technique that has been growing for resources data collection over the past 25 years is satellite imagery. It is relatively low cost, over time, in relation to the conventional air photographic survey. The other great advantages are the repeatability and area coverage that make it useful for monitoring, and the great spectral resolution in the case of the earth resource systems such as Landsat and SPOT. The major disadvantage is the poor spatial resolution compared with conventional air techniques. Remote sensing images can provide data about plant communities or even small communities and environmental conditions, but are not suitable for studies of individual organisms (Johnston and U.S. Environmental Protection Agency, 1989). It is particularly a useful solution for forest inventory in areas that lack basic information.

These methods employed in a systematic way enable information to be obtained on the park ecosystem functioning and conditions which can be used as input for management planning and scientific research (East et al., 1978; Price, 1983) and for preparing management plan proposals (Gwynne and Croze, 1976).

Information on resources is important for parks. However, data collection demands resources which are seldom available for parks in developing tropical countries. Alternative methods should be sought, for example in terms of spatial data collection methods, SFC presents a good alternative for mapping particularly small areas. The São Paulo State has a good topographic map scale such as 1:50000, and in some parks such as PECJ and PEMD has maps at a scale 1:10000. SFC could be useful for monitoring restoration areas and fire hazard analysis in small areas.

2.4.2- Human uses impact and information needs

The existence of parks has been justified as potential source of income produced by the entrance fare charged to the visitors. One of the objectives of a park is to provide recreation. Recreational use has been considered a valid and less disrupting human activity for parks (Hendee et al., 1978; IUCN, 1984; Lucas, 1990).

However, it may put the parks resources at risk, if not properly managed. Recreational use might cause erosion, pollution, crowding, disruption of wildlife and of indigenous people (see Jefferies, 1982). In this sense, could even be put side by side with the well known threats to the park resources such as illegal mining and vegetation exploitation. For example, parks in the Himalayas such as Saghamartha have been under strong and arguably excess pressure from foreign visitors (Jefferies, 1982). In the State of São Paulo, there have been parks such as PECJ, PETAR, EEJ e Parque da Cidade which have received large numbers of visitors which can be a menace to the resources if not properly managed (DRPE-IF , 1992).

Without suitable strategies for management, the consequences and impact of misuse and overuse might cause destruction of resources and reduce the quality of recreation itself. Recreational and visitor management requires an understanding of several aspects of visitor use such as amount and distribution of use, length of stay, timing of use, and behaviour (e.g., preferences for certain places, concentration in places) (Hendee et al., 1978). Visitor data collection and other studies serve to identify potential problems and to elaborate or re-assess strategies for visiting uses.

Other relevant aspects for study are the human impacts on the natural resources (vegetation, wildlife, soil, drainage). This is directly important for park management. For example, carrying capacity information can be useful in setting visitation limits and for devising and changing management strategies (e.g., opening new visitation trails). Dingwell (1977) notes that studies of carrying capacity might be useful to identify the tolerance of plant and animal communities to different forms and levels of recreational use. This can be particularly necessary for areas with high visiting demand.

The type of studies required in parks, both human or ecological, will depend upon the location, size aspects, human and biophysical characteristics of the area. In the State of São Paulo the size of parks varies from about 300000 ha to 40 ha. Certain areas are near urban settlements, in some cases close to large cities. Others are

surrounded by pastureland and agriculture that disturbs wildlife dynamics (e.g., breeding, feeding). There are areas that are inhabited by indigenous people, and some of them have high visitor demands. Additionally, some of these areas contain endemic species in critical risk of extinction, which require management for restoration, such as the Black lion Tamarin in State Park of Morro do Diabo.

It is therefore relevant, firstly, to define clearly what research is required, what is its importance and contribution for management, which is most urgent, and which agencies (government, NGO's, private, international and so like) could contribute to research development. To determine the priorities in research and data collection, it is crucial to consider the limit to resources faced by park planning and management, which is so often the case in developing tropical countries such as Brazil.

2.5 - Data issues for conservation in tropical parks

Humid tropical areas contain the highest biodiversity of any terrestrial ecosystems, but there is a limited tradition of long-term research and monitoring (Lugo and Brown, 1982). There is an insufficient knowledge of the functioning and structure of tropical forests (Maslen, 1992). Concerning research and use of scientific information in the conservation of tropical reserves, Touber et al. (1989) note that often it has been scattered, monodisciplinary and of short duration, without effective application in the area itself. To some extent this is due to funding and shortage of human resources. Even in protected areas such parks and reserves, which should serve as a laboratory for conservation scientists, they have proved to be of limited use. In general there are inadequate structures to support research and inadequate manpower and budget for continuous data collection (IUCN, 1980). These problems also affect the State of São Paulo (see chapters 6 and 7). Therefore, ecological data collection tends to be a discontinuous process, and rarely updated. Yet, ecological monitoring gives the basis to the understanding of these systems. One of the few exceptions is the Luquillo Forest Biosphere reserve in Puerto Rico, where scientists

have been involved with ecological monitoring activities (measurement of biotic and abiotic parameters to understand how the ecosystem functions) since the end of the last century (Lugo and Brown, 1981). Sobrevilla (1990) observes that in tropical areas there is even a lack of basic ecological data such as taxonomic lists of species.

Furthermore, in Brazil there still is a lack of priority and investment in ecological and conservation research and studies. Concerning the lack of knowledge in the domain of the Mata Atlântica, Leitão Filho (1992)[1] notes that there was some change in the 1980s as a result of the growth of international and national conservation movements, but with little tangible outcome to the present. In São Paulo, the most developed and rich State, with a reasonable research infrastructure maintained by the State through three State Universities and Research Institutes, only recently was a joint-project involving these institutions (USP, UNESP, UNICAMP, IF, IBt) proposed, and started, to collect floristic data for natural areas within the State.

Additionally, ecological research is recent in Brazil, particularly within parks and reserves, and studies of fauna and management represent a new science. Of 341 projects registered in the Forestry Institute (IF), only 22 are concerned with fauna (DRPE, 1992). Almeida (1982) notes that the research and teaching of fauna in the Brazilian Universities only started during the 1970s. He notes that the majority of research is carried out in planted forest, concluding that more support for research in natural fauna forest is required.

Another serious concern with information use and access is the lack of an integrated approach for the study of natural resources. Diegues, the co-ordinator of the Programme for Brazilian Humid Areas of IUCN, states

> *"A great deal of the information generated in the University does not lead to conservation. (...)First, most of researches in Universities are developed per species, or part of habitats; most of them totally exclude*

[1] See H. de F. Leitão Filho- expert in Botanical and ecological studies from the UNICAMP, in Munhoz, 1992, p.8.

the humans that live in those habitats. (...) Then, we rarely have a vision of the ecosystems and of the relations that exist among the abiotic, biotic and human components (...) The second reason is that even producing a reasonable volume of general information about environment, there is too little information applied to conservation." (1990, pp. 50-51)

DRPE-IF (1992) identifies the existence of 166 research projects in 1992 within state parks under Forestry Institute administration. It was found, however, that the main problem was lack of monitoring of the development of research and of integration of research. It is also necessary to apply research that is already complete (though little known), which has important implications for management and conservation. Furthermore, it is necessary to train scientists and technicians to give support to research within these areas. It seems that in terms of research, a better policy is required together with appropriate tools to guide and co-ordinate research tied to management needs and priorities. DRPE-IF (1992) mentions the need to create and implement a database and system to monitor and integrate research in all state parks and protected areas.

A key information issue is concerned with presentation of research data, Croze (1984) and Diegues (1990) note that conservation data flow from researchers to decision makers and managers has not been very effective, either because available data are not accessed by managers or are not transformed into palatable format to enable this knowledge to be applied. It is recognised that it is necessary to improve the communication and dissemination of scientific work that already exists in the conservation organisations and research centre for conservation management in Brazil (Sobol, 1990; Costa, 1990; Diegues, 1990). Harmomon et al. (1993) stress that for research to be truly useful for conservation management, it needs to be presented not only in scientific publications but also in a format useful for parks managers and their agencies and for the general public.

Data collection is an essential stage in the park management process. However it is just a small part of the information process that includes management, analysis and application of information. Many of the data have a geographical nature and

therefore can be spatially represented. Thus, any attempt to implement an information system approach for the purpose of resource management needs to search for techniques that integrate different kinds of information. Geographical Information Systems (GIS) have the capabilities for integrating spatial and non-spatial information in a common framework, putting information into an overall system approach (see next chapter for details). Parks in Canada and USA have incorporated GIS in the process of information management for more than a decade. This includes the integration of GIS with ecological models. However, models often require specific types of data or parameters that are lacking in Brazil. Simulation models which attempt to mimic the dynamics of the system cannot given accurate predictions with incomplete data (Grimsdell, 1977). The shortage of ecological data is much more serious in the parks of developing countries as indicated earlier. Additionally, Wright and Machlis (1984) note that park managers need to be trained and educated to the use of such models.

Nevertheless, the change towards an automated information system as GIS, requires specialised staff, which demands training programmes, and specific hardware and software. The introduction of GIS technology in the information management process is time-and cost-consuming and therefore, needs to be carefully assessed. Halffter (1985), Machlis and Neumann (1987), CIMA (1991), and IUCN (1986) show that the organisational capabilities of parks in tropical developing countries are constrained by lack of resources for implementation of management recommendations, and lack of continuity in policy. IUCN (1986) notes that tropical park managers rarely have sufficient trained staff to allot to specific duties compared to the well-developed and intensively-managed systems in most temperate countries where the park staff may include specialists in various fields of management (e.g. planners and interpreters).

In their study about the threats to neotropical parks, Machlis and Neumann (1987) found that one of the most reported threats to parks was the lack of skilled

personnel. Redclift (1987) observes that the relatively low priority given to parks by the Brazilian government is evident from the minimum budget and staff allocated to the national agency responsible. Many of these national parks are virtually abandoned. For example, the National Park of Emas in the Federal District, extends over 120,000ha but it has only two staff in the field; and the National Park of Pantanal in Mato Grosso does not have a single person from the Brazilian Environment Institute, the agency charged with National Park administration (CIMA, 1991). Additionally, when there is government investment, this is directed more towards to the initial establishment of the parks than in long-term operation and maintenance, research and interpretation (Curtis, 1992). Therefore the next chapter analyses the use of GIS and the appropriateness of such technology to the parks of developing countries by considering GIS tools from an appropriate technology perspective.

CHAPTER 3

The Evaluation of GIS as an AppropriateTechnology

3.1- Introduction

Information on resources is the most urgent need for park management in order to achieve the conservation objectives. The information management system is therefore an essential tool in order to collect, organise, analyse and provide information for park management. The development of information system technology such as GIS represents an advance in organisation and integration of data which can support conservation managers and research. However, parks in developing countries face enormous constraints in terms of human and financial resources. The successful use and development of GIS depends much upon the availability of expertise and stable funding. Therefore this chapter will explore the introduction of GIS in the light of appropriate technology.

3.2- The Role of Information Systems

Information and data are terms often equated to facts and knowledge. While data is apparently an empty concept, information is not a 'neutral' phenomenon, and it can be used within a context by groups or individuals as a way of influencing the behaviour of others (Hoos, 1977). Both entities are intrinsically associated, i.e., information transference is only possible with the help of data (De Man, 1990).

Besides, information is a crucial tool to support management activities in the contemporary society, where rapid changes are taking place and information is more available and more in demand than ever before. The intrinsic function of information is to reduce the uncertainties in the management and decision-making process, to help to clarify choices between various alternatives (DeMan, 1990). Therefore, access to

information is undoubtedly necessary to face the challenges of a complex and uncertain world environment.

An information system promotes and organises the supply of information for decision-making, which is essential in an increasingly information-driven society. Handy (1986) stresses that information systems are the nerves of the organisation, which is servicing other systems. However, criticisms have been made about the assumption that the design of information systems is a highly technical matter and best assigned to an 'information expert' (Hoos, 1977).

The introduction of information system technology will change the ways that organisations have handled their data. The change from manual to automated methods will require an understanding of how the equipment functions in order to use it effectively, so that people are able to use the envisaged technology to achieve their aims. Geographical Information System is an example of special type of information system. Because it involves handling geographical data interactively it requires much more sophisticated hardware, software and expertise. GIS technology is discussed in more detail in the next section.

3.3- GIS: Its role in resource management

GIS are special cases of information systems, which manipulate geo-referenced information. Goodchild (1985) defines a GIS as an information system which uses a spatial database to provide answers to queries of a geographical nature. Cowen (1988) defines a GIS as a decision support system involving the integration of spatially referenced data in a problem-solving environment. Such systems are designed for interactive processing of geographic information. These require a specialised and complex set of tools for spatial data capture, storage, retrieval, manipulation and presentation.

The most elementary use of GIS is to handle spatial data rapidly, accurately and more effectively than conventional cartographic techniques, with a benefit of reducing the potential error present in manual techniques (for instance repetition of original map drawing). According to Budd (1992), this technology can provide map output more cheaply than lithographic printing with minimum loss of quality. Furthermore this system has the capability to reduce geographic data analyses time (Shahrokhi, 1986) and to produce a more rigorous data management (Worrall, 1994). The GIS is ultimately a management tool that contains analysis functions that go beyond mere graphic display.

Perhaps the most important part of a GIS is that for data integration facilities, particularly those of polygon overlay, which provide a synthesis of disparate data sources of spatial information and makes inter-relationship between different layers of environmental data explicit. The capacity of GIS for data integration has been stressed by many authors (DeMan, 1984; Rhind and Green, 1988, Aronoff, 1989; Burrough, 1988; Cowen, 1988; Pohchin, 1992; Worrall, 1994). This ability to integrate data of different types and from different sources contributes towards a comprehensive and multidisciplinary approach to natural resource management (see Figure 3.1). Furthermore, Aronoff (1989) argues that the creation of a GIS database would make it a more valuable asset because the data would be more accessible for a wider range of applications. Besides it can improve accuracy by referencing data to a more accurate base map.

Presently GIS packages utilise a relational DBMS (Database Management System) to manage non-spatial attribute data (Healey, 1991). The DBMS ensures that functions such as storage, manipulation and retrieval of data from database, are adequately performed in terms of database security and integrity and data redundancy (Rhind and Green, 1988). Maslen (1992) associates the role of GIS in the

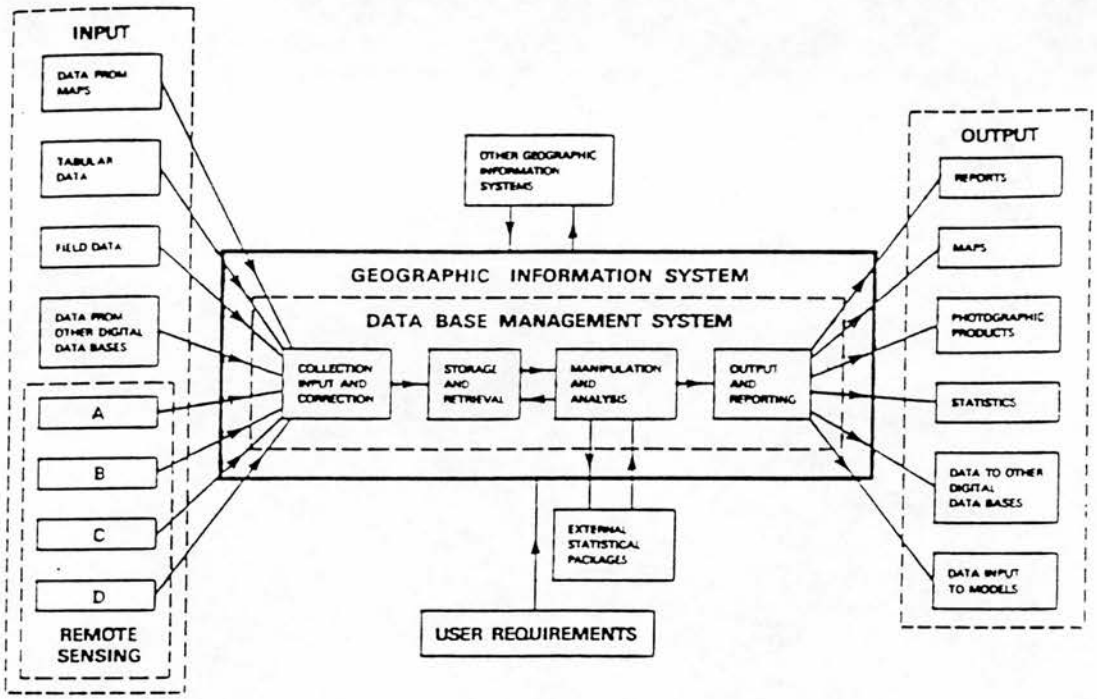

Figure 3.1- Principal components and functions of an idealised GIS for resource planning and management. A, digital data from satellites; B, data from aerial photographs; C, frames from airborne video reconnaissance; D, data from sensors on or near the ground.
Source: Young, 1986

management and organisation of ecological data and for co-ordination of research at a reserve level to the DBMS software:-

> *'The capabilities of the Database Management System (DBMS) to provide centralised control, ensure data quality standards are maintained, apply security restrictions where required and reduce data redundancy would prove ideal in such circumstances.'* (1992, p. 10)

Thus GIS can provide the framework for grouping information for conservation researchers as well managers. There are some key tasks of conservation management that have spatial characteristics that can be linked to the GIS capabilities and functionality- including information gathering, inventory, monitoring, analyses and presentation (Holbrook, 1992). Therefore, a GIS can help ecological researchers and park managers with their wide range of tasks. Table 3.1 shows the relationship between the procedures for management and research of natural resource and GIS functions.

Table 3.1- Linking management and research of natural resources with GIS functions.

Management and Research of natural Resources	***GIS Functions***
Data gathering (satellite imagery, GPS, aerial photographs, maps and ground surveys)	**Data input and capture** (magnetic tapes, digitising, scanning, keyboards)
Resource inventory, description, analysis and monitoring	**Data storage and retrieval** **Analyse functions** (see Maslen, 1992):- **-Overlay analysis**: ability to derive the vertical interaction of spatial data to identify relationships (e.g. organism-environment interactions between tree-soils; interactions between processes such as fire and landscapes; interactions of boundary between vegetation and slopes). **-Spatial coincidence analysis**: calculation of temporal change (e.g. vegetation, land use). **-Proximity analysis**: determination of spatial interrelationships between variables in a horizontal direction. For instance, buffering can be used to assess the selective juxtaposition of species to one another in both raster and vector system.
Data presentation and reporting	**Data Output** (maps, tables, records, etc.)

Environmental historical data, in the form of old maps, aerial photograph and satellite images are valuable tools for assessing characteristics of landscapes that have been changed and, therefore, for regeneration of natural areas and for long-term ecological studies. The USA parks have been using GIS to create long-term fire and ecological database. The USA Everglades National Park compiled a GIS database consisting of historical data on fires (derived from U.S. Geological Survey and park aerial photography survey) on a ten-year period which has been used in their short-term wildfire management and in long-term planning strategies (Rose and Draughn, 1991). Furthermore, GIS databases can be combined with field for ecological studies. One example is the use of maps of beaver ponds derived from aerial photos of Voyageurs National Park combined with field data from aerial counts of beaver colonies to determine how increase of beaver over time affected landscape (Johnston and U.S. Environmental Protection Agency, 1989). GIS has, therefore, proven capabilities to handle environmental historical data.

Yet, Holbrook et al. (1992) argues that users and conservation managers require much experience and knowledge in the benefits and problems of the technology. This can be a more serious problem in developing countries. The use of GIS in developing countries only started in the late 1980s (Souza de, Neto and Alves, 1990; Taylor, 1991). Therefore, there is much less experience with that technology in such countries. In order to realise the value of GIS as a tool for conservation managers and researchers in tropical developing countries, more local expertise and research are required in applying it to the specific environment which is more complex than the temperate countries where GIS technology was developed and has been applied. This approach also requires support from a larger source of basic ecological data.

Taylor (1991) notes that the affluent countries have taken about 20 years to initiate the use of GIS in more substantial applications. The Canadian CGIS was a

pioneer system and had to struggle with some initial failures (technical limitations of hardware and software) before becoming operational and in widespread use by many government agencies (Coppock and Rhind, 1991). One of these organisations is the Canada Parks Service which has been using GIS in many applications including simulation modelling. Therefore, the next section will discuss the experience of Canada and USA parks with GIS technology.

3.4- An Assessment of the Experience of Canadian and USA Parks Service with GIS.

GIS has already been used to support many of the activities in the management of parks and protected areas in Canada and USA (Arbour, 1979, 1983; Rose and Draughn, 1991; Sullivan, 1991; Wagtendonk, 1991; Waggoner, 1991; Knutson and Douhan, 1991; Buckley et al., 1993). These activities include resource inventory and planning, vegetation monitoring, landscape restoration (habitat management), fire management, wildlife management, and the provision of data for research. In these countries many data suppliers have already moved towards GIS such as USA Geological Survey and the Canadian Department of the Environment. In these countries universities and ecological research centres have also been exploring this technology together with Park Services and other conservation organisations (Fleet, 1986; Johnson et al., 1988; Sullivan, 1991; Beardsley et al., 1992). Particularly, Canada and USA have incorporated GIS into their process of park management for more than a decade. Therefore they have experience of the potentialities of GIS technology as a management tool.

3.4.1-The Canadian Parks Service

The Canadian Parks Service has been involved with computer-based technology for the management of resource data since the late 1970s (East et al.,

1978; Day, 1978; Arbour, 1979; 1983). The move towards GIS application in the resource management process comprised the establishment of a number of biophysical databases in the Canada Geographical Information System- CGIS (Arbour, 1979). The CGIS is a general purpose system that is maintained by the Lands Directorate within the Department of Environment.

The Canada GIS is considered one of the most cost effective large spatial data handling systems in the World (Marble, 1990). It is used to satisfy the data handling requirements of large national programs including Federal Land Management; the Canada Land Use Monitoring program; and to assist in Parks Management by providing access to a large base of ecological data (Fisher and MacDonald, 1979). This system has been operating since late 1960s. It contains a digital archive of some 10000 maps on more than 100 different topics (Coppock and Rhind, 1991). It contains information on many land use categories including forestry, recreation and wildlife.

It is worth emphasising that the Canadian Park Services undertook an evaluation programme to examine its spatial data handling requirements for computer applications in the management of the resource data in the late 1970s (see Day and Tomlinson, 1978; Day, 1978; Day 1979). They evaluated the clients' data processing needs. Evaluations similar to those undertaken by Canadian Parks Service are very important since this helps to identify the users, their needs, frequency of use and problems in data handling. This is an important step which should be taken before a GIS is introduced.

The existence of a powerful, general GIS covering the Canadian continental area, with a large digital database and long experience of operation, facilitated and contributed to the success of introducing GIS to the resource management process of parks in Canada. The integrated environmental system was a crucial factor for parks' utilisation of GIS technology.

3.4.2- The USA National Parks Service

The introduction of GIS in the USA Parks started in the 1970s. This process started in the early 1970s through an agreement involving the National Park Service (NPS) and NASA. It was the first time that a large scale effort had been made to use automated cartography to aid park planning (Sudia and Dinkel, 1979). Despite the critical obstacles posed particularly by the development of technology, hardware cost and software limitation, the use of GIS grew in the 1980s. Fleet (1993) points out some factors which contribute to and stimulate the growth of this technology within the park service. These included the availability of powerful public-domain software such as GRASS for UNIX workstations, developed by U.S. Army, and the expansion of the park data sources from LANDSAT, SPOT, U.S. Geological Survey, U.S. Fish and Wildlife Service, Soil Conservation Service, the Forest Service, U.S. Bureau of Census, and so forth. State and Federal agencies are increasingly committed to the use of GIS in support of their functions and also in support of co-operative efforts with other agencies, GIS being a potential medium of exchange (see Dangermond, 1979; Sullivan, 1991; ESRI, 1993).

In 1985 a GIS Division was established to co-ordinate the implementation and use of GIS. It had the role also of promoting and popularising the use of the technology (Fleet, 1993). The creation of a division for co-ordination of GIS implementation and applications implies an increased commitment to technology development within the organisation, and therefore more possibilities to obtain financial resources. The Geographical Information System Division is working with other agencies responsible for producing resource maps, including the Geological Survey and the Soil Conservation Service. The GIS Division encourages the production of digital maps within and adjacent to National Park Services (NPS) areas. These efforts facilitate a more effective use of GIS technology for parks, because they guarantee the availability of data.

The USA Parks are decentralised organisations, with well established human resources and infra-structure (managers, researchers, rangers) compared to African and Latin American parks. Additionally, GIS establishment also follows a bottom-up approach (Fleet, 1987). There are about 110 NPS GIS databases, with themes including elevation, slope, aspect, vegetation, boundaries, roads, trails, ownership, wetlands, cultural resources, and a wide variety of descriptive and prescriptive management zones (Fleet, 1993). Furthermore, there has been inter-agency co-operation on the application of GIS to ecological studies and with other agencies responsible by environmental data collection.

In the USA, researchers and universities have been increasingly using and exploring this technology in ecological research and within park areas. Researchers from the Universities of Minnesota-Duluth and of Washington derived databases and models for wildlife management and research that the parks service is incorporating into their system (see Johnston and U.S. Environmental Protection Agency, 1989; Sullivan, 1991). There has been close co-operation between both State and Federal Universities, and U.S. Park Service in the construction of park ecological databases and in GIS utilisation for ecological problems (see Fleet, 1986; Agee et al., 1989). Fleet (1986) also gives some examples of the contribution of the Federal and States Universities in the creation of ecological databases for parks with management applications. ESRI is working for USA NPS together with a pool of organisations (NCGIA, The Nature Conservancy-TNC, Aerial Information System, etc.) to develop standards for plant community and the mapping and development of digital vegetation database based on standard for U.S. National parks (ESRI, 1993).

Thus, GIS technology is not only about acquisition of technology but involves skilled personnel, maintenance of the system, multiple organisational effort and investment, particularly for data collection and exchange. Developing countries have much less experience with GIS technology which was developed in the research

centres of developing countries. In developing countries, parks organisations generally are under resourced and receive lower priority in budget allocation (Redclift, 1987; Faria, 1990; CIMA, 1991), therefore the introduction of GIS technology should be careful evaluated.

3.5- Potential constraints of high-end GIS tools: An example of ecosystem modelling requirements

Part of the increasing sophistication of GIS software has been in providing capabilities for integration with simulation modelling. The Canadian Parks Service for instance developed the Ecosystem Management Model Project within the Elk Island National Park, integrating a FORTRAN-based ecosystem simulation model and ARC/INFO GIS, in order to allow predictions of mammal population dynamics and their effects on vegetation succession (Buckley et al., 1993). The critical need identified during the design process was the requirement for a detailed vegetation inventory to support the modelling procedure. Burrough (1993) also identifies data constraints in adopting a sophisticated environmental modelling:-

> *'Many models of environmental processes are complex and may require data at levels of spatial and temporal resolution that are too costly to collect.'* (1993).

The viability to develop this ecosystem management model project, with integration of GIS was possible due to the availability of sufficient expertise and technology to construct the models to simulate management actions and ecosystem processes and availability of data and knowledge to refine and calibrate models. The GIS software requirements to develop this specific Ecological Management Model demanded (see Buckley et al., 1993):-

- operation in UNIX workstation platform due the expected processing requirements;
- comprehensive graphical user interface for displaying the model;

- integration of raster and vector database spatial analysis.

This project also required compilation of data to produce specie density maps. Therefore it can be concluded that the demand of expertise and data to develop and use and the sophistication of equipment are very high. As the above examples show the more complicated are the uses, the more functionality is required for the GIS demanding more sophisticated spatial analysis (overlay, buffering, DEM, etc.), interface with models and more sophisticated hardware such as workstations to deal with the large volume of data processing.

GIS can also be used for simple applications such as to show spatial distribution of resources (vegetation, soils, etc.) which do not demand more complex functions. Thus *low-end* GIS tools can be performed by mapping packages such as Mapinfo. It can perform this function as they are oriented towards the presentation of data connected with areas, and they are user-friendly, low-cost, easier then real GIS packages, produce good quality maps and can be connected to readily available DBMS packages such as DBase (Meijer, 1989). However, this system does not fulfil the requirements of the Canada Park Ecosystem Simulation Modelling. But, Mapinfo can help to improve spatial data handling and it is easy to use and does not demand large hardware (workstation) as it is PC-based system. Furthermore, it is more likely to be affordable to the organisations which do not have the resources and expertise such as those of Canadian Parks.

It is obvious that data is a great requirement for exploring all the potential that the system can offer for ecological management and research. This requirement may be unresolved in the context of data management of the state parks in São Paulo, where detailed ecological data are still lacking and an ecological monitoring system is not available on the ground as chapters 6 and 7 will show.

In circumstances where there are funding constraints to purchase GIS, it is very important to be aware of the sophistication level and requirements of GIS and

how important and feasible they are for the objectives and current situation. This can help to provide a more careful start. As Fox (1991) notes, the software for large-scale systems is mainly purchased from the developing countries and is expensive. Furthermore, without adequate expertise, a sophisticated system can be underused, i.e., people may use only the basic functions (e.g., mapping function) because of inadequate knowledge of the system possibilities.

3.6- GIS: Institutional constraints in developing countries

It is recognised that organisational and institutional factors are the main barriers to GIS implementation and successful utilisation in both developed and developing countries (Croswell, 1989; Onsrud, 1989; Cornelius and Medyckyj-Scott, 1991; Fox, 1991; Peuquet and Bacaslow, 1991; Teeffelen et al., 1992; Burrough, 1992; Campbell, 1992; Meijer and Kuipers, 1992). The implementation of GIS technology demands a very specialised staff and equipment, that involves the cost of personnel training, database creation and maintenance, and acquisition of hardware and software. Moreover, as Teeffelen et al. (1992) stress, the initial expense to set up a full GIS requires the purchase of powerful, or perhaps several computers, software and also peripherals such as digitising tables, printers and plotters. The full details of required GIS hardware are not included in the information system purchase costs. As the above example of Canada has shown, the requirements for a sophisticated ecosystem monitoring system demand more powerful computers such as workstations and, this system level would demand a considerable expertise.

The institutional problems related to GIS technology implementation appear to be greater in developing countries. Fox (1991) identifies some constraints in the adoption of spatial information technology, in the environment of Asian countries, that are more related to institutional rather than technical factors. Those pitfalls include rigid and centralised bureaucracies; lack of co-ordination and communication

interagency, that results in failure to share information, and in duplication of efforts; shortage of appropriate training programmes and cost. The Southern African countries are also experiencing similar constraints in the implementation of GIS. Bujakiewicz and Mulolwa (1994) found that among the major problems of GIS in Southern Africa are lack of skilled manpower and awareness on part of decision makers, and users; and lack of funds and training institutions. Lack of funds was mainly cited with respect to the cost of hardware and software. One of the main reasons of lack of manpower is the failure to retain skilled personnel at low wages. Teeffelen et al. (1992) also point out the risk to the government sector in losing local trained staff to the private sector due to the salary issues in the developing countries. Besides, another example of the most critical problems pointed out by Division of State Parks and Reserves of the State of São Paulo has been shortage and lack of regular training programmes (see DRPE-IF, 1992).

Koppen (1992) points out that the use of GIS in Indonesian government organisations has been constrained by factors such as the poor financial budget which hampers both automation and the employment of qualified personnel. Teeffelen et al. (1992) consider that the three main constraints that impede the effective development of GIS applications in developing countries are concerned with financial, human resources and data issues. Furthermore, most of the GIS hardware and software used are imported from developed countries, and software for a large-scale system is expensive (Yeh, 1991).

The study by Croswell (1989) based on a review of literature on experiences in developed countries, indicates that the obstacles related to the technical side of GIS implementation and operation are assigned less importance compared to organisational problems such as co-ordination and communication aspects. Therefore, the success of GIS depends largely on the many and complex organisational factors, and in changes in organisational practices. Despite the problems of funding, in

developed countries this is not the main or most obvious organisational problem, when compared to the developing countries. It seems therefore, that because GIS technology was developed in those more affluent countries, where funding is more available, it is possible to improve the evaluation of the different organisational aspects affecting success of GIS technology.

A comprehensive and rapid GIS implementation may not be feasible in the developing countries. It can take a great deal of time, even in industrialised countries, to consolidate GIS technology within an organisation (Burrough, 1992; Aronoff, 1989). It would probably require much more time in developing countries.

Economic justification is a critical factor in the decision to buy an information technology by a public agency. This can be difficult particularly for government organisations of developing countries. Therefore, starting with a modest system may be more practical and realistic than attempting to install sophisticated systems quickly. Considering the lack of money and human resources, the choice of the system should be oriented towards alternative, low-cost and easy to use technology, such as microcomputer based systems and simple software, not the latest high technology. Teeffelen et al. (1992) argues that starting small, i.e., by using for example basic mapping software, allows for a more gradual approach in acquiring the necessary skills to deal with GIS technology problems. Appropriate technology is deemed to address such issues and it is further discussed in the next section.

3.7- An alternative solution for GIS introduction in developing countries

3.7.1- Appropriate technology and resources scarcity issues

The origin of the Appropriate Technology movement is closely rooted in the economic development philosophy prevailing in the industrialised societies. The predominant development paradigm emphasised economic growth of gross national product based upon the expansion of capital-intensive industries and foreign

technology (Willoughby, 1990). The most seminal critique to that philosophy of development was provided by Schumacher:-

> *'A 'modern' workplace, moreover, can be really productive only within a modern environment, and for this reason alone is unlikely to fit into a 'district' consisting of rural areas and a few small towns. In every 'developing country' one can find industrial estates set up in rural areas, high-grade modern equipment is standing idle most of the time because of lack of organisation finance, raw material supplies, transport, marketing facilities, and the like. There are then complaints and recriminations; but they do not alter the fact that a lot of scarce capital resources- normally imports paid from scarce foreign exchange-are virtually wasted.'* (1973, p. 174)

Intermediate technology emerged as an alternative strategy to the transfer model of high capital-intensive technology from industrialised countries to the poor countries of the South.

To Bhagavan (1979), intermediate technology means somewhere between traditional and modern. However, the term appropriate technology has been more widely used today, and in some way embodies the ideas of intermediate, low-cost (focusing on the 'economic dimension' of innovation, i.e., less expensive than modern technology) and soft technology (a concept developed in the advanced-industrialised countries for technology which causes less ecological and environmental impact than the chemical and nuclear energy technology) (Jéquier, 1976; Bhagavan, 1979). Although terms such as Intermediate and low-cost has been used for developing countries and soft more for developing countries all them emphasise the need to look carefully at the impact and at the real needs of the society. These terms have been used as interchangeable. The appropriate technology represents the social and cultural dimension of innovation as Jéquier states:-

> *'The idea here is that the value of a new technology lies not only in its economic viability and its technical soundness, but in its adaptation to the local social and cultural environment.'* (1976, p. 19)

Willoughby (1990) notes the Appropriate Technology movement has, as one of its main purposes the expansion of available technology choice in circumstances where presently they are in fact limited. An investment in modern equipment and advanced technologies may not necessarily lead to success; this can be particularly serious in the context of developing countries organisations. Schumacher (1973) points out that a lack of organisational facilities, capital and personnel are critical problems in the successful implementation of sophisticated technology by developing countries. Hence, the acquisition of sophisticated technology can result in a waste of the already scarce capital asset, if there are not the required organisational facilities and resources.

The AT movement was focused on the issues of the development of the rural areas and in the agricultural field of the 'third world' (Schumacher, 1973, McRobie, 1984, Willoughby, 1990). However, there is a recognition that the idea of large-scale technology being appropriate for the 'developed' countries and intermediate or appropriate technology for the 'developing countries' is false (McRobie, 1984; Willoughby, 1990). In some way technology should be selected based on its appropriateness for the particular purpose for which it is intended, within a particular organisational environment. Clegg and Durkeley (1980) point out that in the choice of technology it is necessary to raise the issue of who is making the choice and to what end. These are two crucial questions in the process of technology selection, that may help to discriminate between the potential alternatives based on their suitability for a specific context. Baghavan (1979) argues that the term appropriate technology is a fluctuating one in time and space even within and among developing countries. For instance, what is traditional in South Asia, such as an ox-drawn plough is regarded as intermediate in Tropical Africa. Therefore, what constitutes an appropriate technology can vary in time, place and purpose.

The appropriate technology can, however, provide a framework for judging the nature of envisaged technologies and viable alternatives in certain contexts, thereby developing a suitable framework for dealing with technology selection. McRobie (1984) stresses that the advantages of smallness and simplicity as being capital and resource-saving, which are essential for the technologies of both developed and 'developing' worlds. Obviously, the resource constraints of the 'developing' countries are a much greater issue in the maintenance of technology and change towards automation. Furthermore, most information technology software and hardware are imported from developed countries. The human resource pitfalls are even greater in the developing countries which have less opportunities for higher and technical education (Masini, 1990).

In relation to the technically oriented criticism of efficiency of appropriate technology, Willoughby (1990) argues that it fails to recognise a distinction between internal technical (or engineering) efficiency and the external efficiency of the same technology, i.e., its efficiency in achieving certain human or practical ends while operating in the complex 'real' world. Scarbrough and Corbett (1992) note that the decision making process and management of technological change in many organisations, is dominated by technical considerations and an engineering logic of efficiency that emphasises the need for the latest software and hardware even where no clear benefits are likely to result. Thus, technological change cannot be divorced from the organisational environment, and should not be based strictly on technical factors and solutions. Low-cost technologies may not be so efficient, as the more advanced ones, but may be more suited to a specific use and may contribute to increase the efficiency of technology-practice employed within an environment with limited resources. For instance, a PC-386 is not so powerful as a Workstation but it can be used to manipulate software such as DBMS, Lotus 1, 2, 3, CAD packages.

Furthermore, the ease of maintenance and training are important factors to fit technology to places which lack resources and experience.

Jéquier (1976) notes that there have been very few incentives to explore approaches which reconcile efficiency with small size and technical simplicity. He gives some examples of change in some sectors like electronics. The information technological field has been moving from a large expensive main-frame towards efficiency at low-cost, with the growing use of the PC-micro computer based technology (portable systems and fast processors). This factor has been contributing to make computer use widespread even in developing countries. Furthermore, the fast growing of information technology has been making prices more affordable rapidly.

The range of technological options and the consequences of its implementation should not be overlooked whatever the context, but particularly where there are resource constraints like the organisational environment of developing countries. There is a recognition that poor choices of technology can and frequently occur, and that placing more attention on the processes of technological choice may create a basis for better policies and practices (Willoughby, 1990). The important question is how the concept of AT can be part of the planning and decision-making environment of the government. The shortage of resources in government organisations, particularly of 'developing' countries may bar access to some of the more advanced technologies. This is particularly bad in organisations responsible for the management of conservation areas such as the protected areas system in Brazil and at more even regional levels. The State of São Paulo has the second largest public budget after the Federal one, yet it allocates a very small proportion to the environmental sector (SEADE, 1992) amongst which is the IF. However appropriate alternatives should be sought that make maximum use of the meagre resources available. Sophisticated technologies which lie idle are not the most efficient use of these resources.

The claim that an appropriate choice of technology ought to be treated as a cardinal policy concept (Willoughby, 1990; Knudsen, 1992) is of great importance to the decision-making process that involves information technology, including GIS, an innovation in the field of spatial data handling. It is a complex and yet expensive technology, that requires specialised personnel and organisational support for its success, and has been subject to many organisational and human drawbacks even in the developed countries (Burrough, 1992; Meijer and Kuipers, 1992).

The strength of the appropriate technology is embodied in the recognition of the need for knowledge of the many technical alternatives and options, and their suitability for a given purpose and situation, and for careful analysis of the environment. In essence, the selection of technology involves factors that go beyond merely the solutions of technical efficiency. However, the choice of technology may be inappropriate due to decision-making problems such as lack of information about available technologies and needs, and choice based on political-personal decisions rather than a more rational approach. As Hommes (1982) and Dijk (1982) indicate, knowledge about the availability of certain technology is one of the main factors influencing the choice of appropriate technology.

One of the criteria to be considered as appropriate technology is low-cost, use of local resource, and independence of import duties and consultation fees (Darrow and Pam, 1978). However, for modern information technology such as GIS it seems to be a contradiction as it was developed in the industrialised countries laboratories and is mostly imported. Therefore, the next section will discuss the potential solutions to this issue.

3.7.2 - GIS: A Perspective of appropriate technology.

The development of PC-GIS software is opening a perspective to make GIS technology more accessible. Some developing countries have their own GIS in-house

developments, such as Brazil for example. In the 1980s, INPE developed a PC based system which was acquired by a few universities and government agencies such as EMBRAPA (Souza de, Neto and Alves, 1990). This helped to disseminate the use of GIS in Brazil in the late 1980s. However, this system is not free. It demands training and database maintenance. Additionally, PC-GIS, such as ARC/INFO and MGE (Intergraph) are costly[1], require long training (they are not easy to use) and technical support which involve the payment of high fees. Workstation GIS are far more expensive and demand more expertise and training (Table 3.2).

Table 3.2- Prices of Brazilian in-house and foreigner GIS software[2]

Platform	*GIS*	*Price(US $)*
PC	ARC/INFO	8,000
	ERDAS	12,000
	SGI (INPE)	4,000
WORKSTATION	ARC/INFO	30,000
	ERDAS	40,000
	SPRING(INPE)	20,000

Furthermore, a minimum GIS hardware requirement with microcomputer, plotter, digitizer and a printer can cost about 10,000 dollars (Yapa, 1991). This may not be affordable by many organisations in developing countries, even in more industrialised ones such as Brazil. Additionally, this price does not include software (see above, Table 3.2), training, data collection, expertise and infrastructure requirements.

In assessing GIS in the light of appropriate technology Yapa (1991) argues that is it difficult to equate GIS systems such as PC- ARC/INFO with appropriate technology, considering the cost of the equipment, the requirements of high-level

[1] Both companies have vendors based in São Paulo, Brazil.
[2] Information provided by the head of DPI-INPE (1994).

western-style education for consultation and training, and the fees for such services, which the organisations of many developing countries can not afford. In other words this is a system developed to be used in the organisational environment which provides high level support training in GIS concepts and applications.

Many studies of GIS implementation have suggested that developing countries organisations start small (Yapa, 1991; Teeffelen et al., 1992; Meijer and Kuipers, 1992). Meijer and Kuipers (1992) emphasise the need to consider what they called *'low-end'* GIS tools. This alternative integrates mapping software with commercial database packages such as DBase III, and has been adopted in countries like India for urban problems (Meijer and Kuipers, 1992), in Taiwan using AutoCAD and DBaseIII for National Parks (Wu and Lin, 1989), and in the integrated Rural Development Programme offices in southern Sri Lanka (Yapa, 1991). These tools are usually readily available in these countries and are easy to use and maintain. Teeffelen et al. (1992) argue that is preferable to start 'small' by selecting basic and inexpensive data handling software before 'real' GIS packages, in order to familiarise users and decision-makers with new data handling technology and to identify its potential and its problems.

Additionally, Meijer and Kuipers (1992) point out that both data requirements and the characteristics of the local organisation involved in the field of interest will heavily influence the choice of GIS tools. A GIS used for ecosystem management, such as the mentioned example of Canada, will require *'high-end'* GIS tools which require very sophisticated hardware and software such as Workstation ARC/INFO. Increasing sophistication of hardware will demand more sophisticated expertise, for instance workstation will require a computer manager. However, the constraints in expertise and funding, associated with the lack of experience with such technology of developing countries will not make it a viable tool for management, at least in the initial stages.

The greatest constraints on successful implementation of high-end GIS tools in developing countries are those of funding and human resources (Masine, 1990; Koppen, 1992). The organisations have to develop skilled local personnel in order to operate and apply high-end GIS tools effectively. Furthermore not only are people with computer skills required but also those who can identify the needs, explore the potential applications and train others. This requires trained personnel. In the case of parks, if predictive modelling is to be used, it will involve ecological expertise who knows the potential of using GIS for the required objectives. Furthermore, by training personnel in computer skills there is the continual risk of losing the personnel to the private sector which is able to offer higher salaries (see Teeffelen et al., 1992).

The difficulties in considering GIS as an appropriate technology is related to the high demand for expertise, fees for the service, and so on. Yapa (1991) identifies two broad approaches to start GIS at low-cost in developing countries. One is to adopt low cost integrated packages such as IDRISI, which was developed in Clark University. This system is a cheap grid-based GIS which is capable of importing vector-based maps. This was developed to work on a PC, but contains functions such as digital image processing and overlay analysis, which are useful for environmental management. The other approach is the use of a loosely-integrated system built around existing database and graphics packages. An example of it is the CARP system which was developed at Pennsylvania University to integrate popular CAD software such as AutoCAD (drawing editor) and a database manager (DBase). The latter is one alternative which consider the existing software infrastructure more commonly found in the developing countries such as AutoCAD package and DBase system. Yeh (1991) argues that these systems although limited in their GIS functions, can make GIS available to departments and agencies with little funding.

Therefore, these alternatives cannot be thought of as second best, but as suitable solutions which fit to a specific organisational capacity and needs. There is no

point in having a powerful workstation ARC/INFO if there are insufficient and inadequately trained personnel to use it to its full potential and to manage the technology. The PC based CAD systems are very easy to use and to maintain and do not demand high level expertise. It is a system easily understood by non-computer specialist. This is important where higher training is more difficult to provide. As Aronoff (1989) notes the user-friendliness of a system will directly affect the time and, therefore, money needed for training. Obviously, there are trade-offs to consider, a CAD package can not perform functions, such as overlay analysis like a real GIS package. Additionally, a GIS based in Workstation platform allows for more fast processing and efficiency of storage. However, the more complex the system, the more highly trained and costly software persons are required to bring the system in operation.

Capital for the acquisition of GIS may be available through government or international agencies such as the World Bank. Taylor (1991) notes that GIS initiatives in developing countries have often found themselves dependent on foreign support However, the most difficult problem is to have financial resources to run the GIS. Even if there are funds to buy the technology, it can be very expensive to maintain it, and therefore difficult to keep it fully operational in developing countries government organisations. As Yeh (1991) notes, very often systems cannot operate because terminals and peripherals are out of order and the agency does not have funds to repair them. The more sophisticated are the systems, the more demanding the expertise required to do their maintenance and management. Furthermore, database maintenance is a *condition sine qua non* for an information system to support environmental management and studies, and data, particularly ecological and socio-economic data are not readily available, or cannot be obtained in developing countries. The IDRISI can be a low-cost alternative package, which contains sophisticated functions such as digital image processing. However, the digital images

are not free. In Brazil, INPE charges about US$ 3,000 for the 7 bands. Furthermore, according to Jong (1992) the IDRISI performs best using EGA colour.

The development of in-house software is most required, nevertheless, the development of low-cost GIS alternatives is still coming from the research laboratories of developed countries such as IDRISI. One of the prospects for GIS technology to become an appropriate technology is the development and improvement of low-cost GIS packages and of public domain. Until then, alternatives should be sought based in Yapa approaches. These will depend both on what is already available and the users requirements. CAD based systems, even imported, are presently more accessible in the environment of developing countries. However, systems such as IDRISI are easy to use, low-cost (transportation cost only), provide functions such as overlay analysis and digital image processing, and has good documentation. SIG/SITIM is a national system similar to IDRISI and it is provided with training by INPE, one of the diffusers of this technology in the Brazilian government institutions, but it is not a low-cost software.

The development of public domain software is clearly a good option for access. However, software such as GRASS can only run in a workstation. Therefore, it requires sophisticated and expensive hardware to be used. The adoption of local software such as SIG/SITIM developed by INPE in Brazil is a guarantee of good training and local support. However, it involves buying the whole package from software to hardware. Furthermore, there has been an increasing introduction of foreign software and vendors with local support such as Intergraph and ARC/INFO, but they are still expensive in terms of software and technical support, and require well trained human resources and expertise.

Therefore, a set of criteria is suggested by which GIS can be evaluated as AT in a specific context. These criteria should consider factors such as smallness, ease of

use and of access. Figure 3.2 summarises the previous discussion about the criteria by which it is possible to evaluate how appropriate is the technology of GIS.

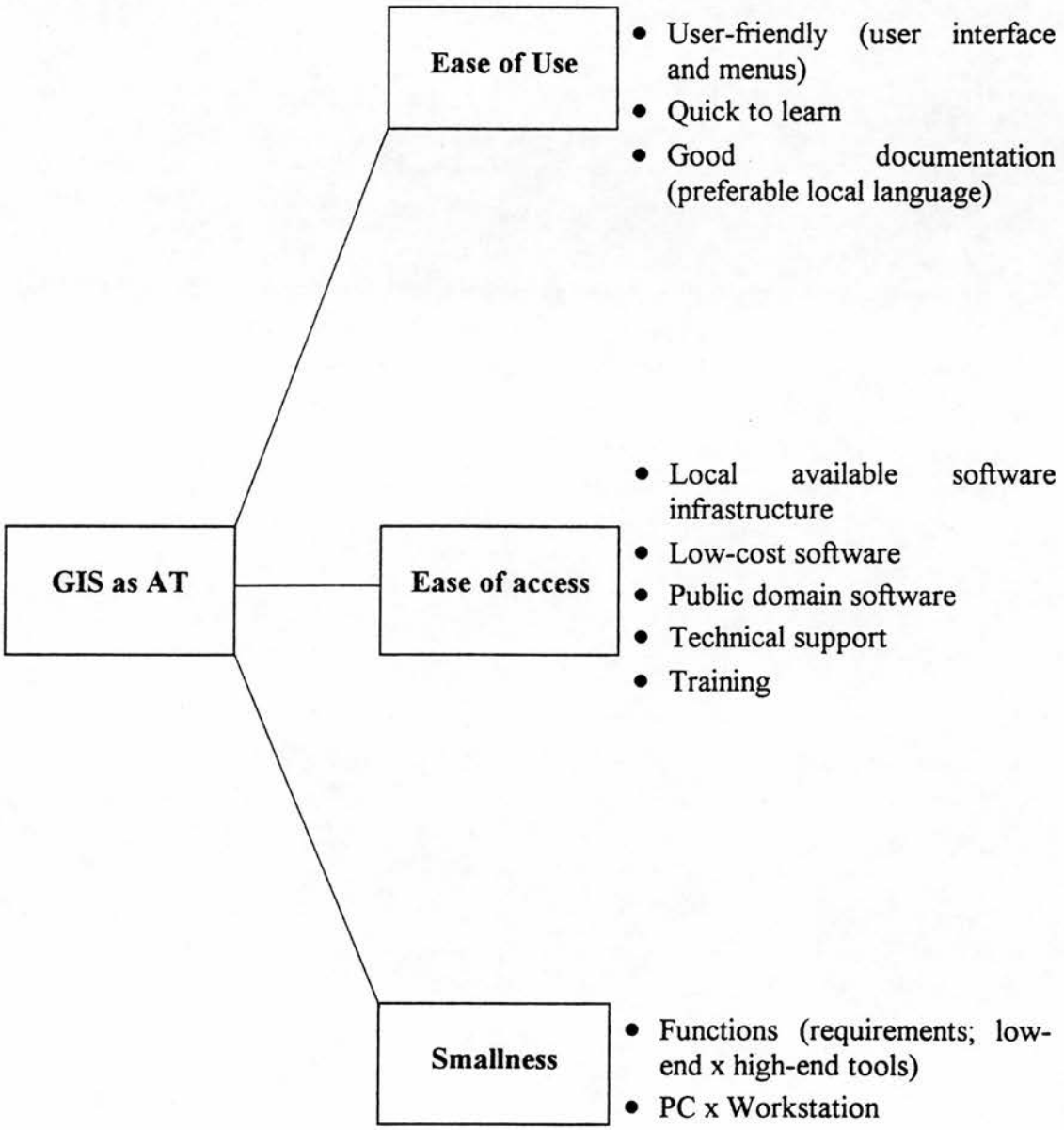

Figure 3.2 - Criteria to evaluate GIS as AT

3.8- Discussion

The GIS technology has been incorporated in and applied to different activities within parks of developed countries such as Canada and USA. This research looked

particularly at the experience of parks in Canada and USA with GIS because of the similarity of their roles and natural resource characteristics to Brazilian parks e.g. in having extensive remnants of natural biophysical resources and in their land being publicly owned. Parks in England and Wales are smaller in extent, have fewer remnants of 'natural' vegetation and less of their land in public ownership and were therefore considered to be less suitable for comparison with Brazilian parks as regards potential applications of GIS.

Countries such as Canada have strong environmental institutions and conservation policies. Additionally, Canada was the first country to have a powerful, multiple purpose GIS in operation in its Department of the Environment, with a large environmental digital database. All of that favoured the successful use of GIS. Besides that, parks are well planned and intensively managed and have adequate staff and data resource management. In contrast, parks of developing countries have to face shortage of resources, lack of a management plan or plan updating, lack of priority and lack of systematic data collection. These issues are obstacles to the management of parks. Therefore, the introduction of technological information system support in these countries has to consider appropriate alternatives, particularly when it comes to GIS technology which is very resource demanding. Such a system requires high-level training and funding.

The main criticism of GIS technology in this chapter is that it does not appear to provide a simple option which is resource saving. Instead it has resource demands which may lie beyond the reach of most organisations in developing countries.

On the basis of appropriate technology as discussed in this chapter, there are low cost alternatives (i.e. low-end GIS tools) based on commercial CAD software (e.g. AutoCAD) connected to simple DBMS such as DBase (e.g. Mapinfo and Carper) which are easier to operate and cheaper than the more sophisticated GIS packages such as PC-ARC/INFO. Therefore, these systems allow users to build

expertise gradually. As Teeffelen et al. (1992) stress, it is likely that the introduction of such systems can develop more successfully the general knowledge of computers and awareness about the problems of spatial data handling. However, the choice of the appropriate technology should also be based on more broad criteria such as those pointed out in Figure 3.2. This choice will depend on the knowledge of users and of their requirements, for instance packages such as IDRISI, Mapinfo or AutoCAD are easy to use and low-cost, but the former has functions that allows the extraction of information from digital satellite images which can be more appropriate for environmental studies. But, MapInfo and AutoCAD are better for digitising and for handling cadastral spatial information. As Jong (1992) notes, although these PC-based softwares are limited regarding the amount of data they can handle, they are suitable for data manipulation at provincial or local level. Additionally, the use of such simple, low-cost or public domain software allows on institution to train people and to introduce gradually information technology. It can help institutions with limited resources to wait for a better moment when more sophisticated technology drops in price and more resources are made available.

Additionally, there is also the issue of self-reliance when it comes to software developed in-house. Unfortunately, there is not much investment in local development of GIS software such as these in developed countries laboratories.

Furthermore, there are also differences amongst organisations in developing countries. Even in wealthy areas of Brazil such as the State of São Paulo, which runs its own park system, there are inadequate resources for the management of parks, and thus to cope with a sophisticated GIS operation even if they are on a more centralised basis. Chapters 6 and 7 will pursue this argument in greater detail. Therefore, as Baghavan (1979) notes, appropriate technology can vary in time, place and purpose, even within developing countries.

CHAPTER 4

Fieldwork: Putting Research into Practice

4.1 - Introduction

This chapter aims to describe firstly the research framework and secondly the methodology adopted in this study.

Whereas the general frailty of the conservation status of natural areas in the Atlantic Forest is reasonably well known, in practice the success or failure of individual parks depends upon local circumstances. GIS is only one of a set of management tools for supporting conservation management and it is recognised that its success depends very much upon local organisational arrangements and available resources. For this reason, detailed analysis was undertaken of two areas which exemplify the problems of developing a successful conservation management structure.

4.2 - Case study approach and the selected areas

The choice of two case studies gives the opportunity to explore in depth the causes of institutional and organisational problems which have beset parks from the past to the present day. An analysis of past problems was important for this research in order to highlight the factors which influenced the process of park establishment and management. This included an analysis of how resources were allocated, by whom and in what circumstances. The aim of choosing these two parks was to produce a framework within which it would be possible to analyse the potential organisational problems posed by the implementation of on-site GIS as a management tool. The introduction of sophisticated technological innovation such as GIS requires a careful analysis of the context in which it is to be implemented. This should include

an assessment of the availability of human and financial resources which are usually scarce in the public organisations of developing countries.

The main problem with the case study approach has been the allegation of limited generalisability (Bryman, 1989). However, with caution, the results of the research can be generalised and extrapolated to other parks. Bell (1987) makes an important point about the generalisation issue:-

> *'Generalizability may be a problem, but the study may be reliable and enable members of similar groups to recognise problems, to see ways of solving similar problems in their own group.'* (1987, p. 8)

The analysis of case studies allows an detailed examination of park organisation and the ability to focus on specific issues which have not previously been examined. One of the strengths of using case studies to examine organisations is stressed by Bryman (1989):-

> *'Case studies are often useful for providing an understanding of areas of organisational functioning that are not well documented and which are not amenable to investigation through fleeting contact with organisations.'* (Bryman, 1989, p. 173)

The two case studies undertaken were the State Park of Campos do Jordão (PECJ), and the State Park of the Morro do Diabo (PEMD). The case study of PECJ was suggested by the Director of the DRPE (Department of State Reserves and Parks) as the most appropriate case study for this research in 1991. This is the oldest state park and is widely considered to be a pilot park in the State of São Paulo (see Marcondes et al., 1983). It was one of the first areas to have a management plan and infrastructure to receive visitors and researchers. PECJ is located in an area of high tourist demand in the State, within the Campos do Jordão municipality, and in the most densely populated and industrialised region of the State (see Chapter 7 for detailed description of the PECJ). PEMD (State Park of the Morro do Diabo) is the

second case study. PEMD is one of the oldest reserves created in the State. Its choice was based on the facility in accessing the park as it was close to the university (UNESP- Presidente Prudente city) where this researcher works. It is part of a region being studied by UNESP. Additionally, this park has different landscape characteristics. Unlike PECJ[1], PEMD is a fragment of forest. Besides that, PEMD is nearly 5 times bigger. It is not a known tourist area. Unlike PECJ, most visitors are scheduled school tours. PEMD is located in a very dry climate subject to fire hazard. Historical-institutional information about the context within which this park had been established was available. It is argued that, as Bryman (1989) observes, a very good reason to include a second case in investigating organisations is that the generalizability of the research may be enhanced, and for this reason a second case study was also used.

Previous contact was made with state parks in 1989 when the researcher developed a map-folder for visitors of PETAR (State Park of the Vale do Ribeira). This contact helped to raise the researcher's awareness of potential issues to be addressed during the main fieldwork, such as those related to information management and the extent and nature of human resources.

The fieldwork was carried out mainly during November 1991 to July 1992. Some further work was carried out between 1994-95. The logistic base was located in UNESP in Presidente Prudente about 600 km from the capital city, where the park central agency-DRPE is located, along with many other government organisations and NGOs. PEMD is about 130 km from Presidente Prudente city, and about 700 km from São Paulo city. PECJ is about 300 km from the central agency.

[1]PECJ is part of a mass of natural vegetation in the Mountain Range known as *'Serra da Mantiqueira'*, which spreads along three states (Rio de Janeiro, Minas Gerais and São Paulo).

4.3 - Data Collection and Analysis

The choice of the data collection method is intrinsically related to the type of research proposed (Bryman, 1989). The approach used in this study was qualitative, because it was intended to find out why and how things happen, and not to force people's ideas into predetermined categories. Miles and Huberman (1994) point out that qualitative research can provide well-grounded, rich descriptions and explanations of processes in an identifiable local context. This was judged to be particularly important in this study, which attempted to identify the nature of the problems faced by the management of state parks and the appropriateness of introducing a sophisticated information technology such as GIS. Therefore, the data gathering process was guided by qualitative research tools. Data were collected mainly through open-ended interviews, documentary analysis and observation. McCracken (1990) points out that unlike quantitative approaches, the purpose of qualitative interview is not to discover how many, and what kind of, people share a certain characteristic, but to gain access to their assumptions and categories. Lakatos and Marconi (1988) note that open-ended interviews allow the interviewees to describe and explain situations with their own 'symbols', and that answers to questions can raise other questions allowing for a more in depth examination of issues raised. The flexible nature of qualitative research approaches is also emphasised by Borman et al. (1986):

> *'Further reports of competently done qualitative studies focus upon the flexible, evolutionary, and recursive nature of the investigation; the emphasis of the paradigm is upon remaining sensitive to the data and to input from the field.'* (1986, p.52)

Such approaches allow the researcher to obtain detailed material for the analysis, which may then be compared with patterns documented in previous related research literature (Borman et al., 1986). In addition, some quantitative data, for example relating to human resources, were derived from documents and enabled a

better visualisation of interview findings. Three main techniques to gather qualitative data were employed:-

4.3.1. Documentary research

4.3.2. Interviews with key informants

4.3.3. Observation

The first stage of the analysis of this thesis started with a literature search in the GIS and in the park management field in order to identify the relevant issues. The most commonly identified constraints on the introduction of information technology and to many GIS applications in developing countries seen in the specialised literature are the following categories: funding, human resources and data constraints (Al-Ankary, 1991; Fox, 1991; Yeh, 1991; Teffelen et al., 1992;). Additionally, as mentioned in previous chapters, IUCN (1986) and Grimsdell (1977) point out shortage of trained staff and funding, lack of knowledge of the complex tropical ecosystems, as limiting factors in park management of developing countries. Tchnell et al. (1983) also found that the one of the worst problems for management of parks in the neotropics is the inadequacy of human resources. Therefore, from this initial analysis some broad themes were derived (human resources, funding and information management issues) which guided the interviews. Additionally, these broad headings helped to organise and classify the material gathered from fieldwork notes and documents. Examples of this classification include:

1. Human resource issues- involved information about staff availability (lack of personnel and function deviation[2]), discontinuity in administration, training and education, and salaries.

2. Funding issues- included information about sources of funds (government and international; institutional problems such as inflation; low government priority for

[2]Assigning qualified function to staff who are not fully qualified and were not contracted to perform that task.

the environmental sector) and forms of funding allocation (too centralised; priority for coastal areas; environmentalist pressure).

3. Information management issues- included information about data availability and data needs, for example.

The interview notes were written up. All information derived from the same source was grouped together (sometimes information was obtained from the same interviewee at different times and places, and written up in a different notebook). The information from the interviewees could be then categorised according to the headings listed in 1, 2 and 3 above. Obviously, these issues are interrelated, for instance, paucity of certain information may be related to inadequacy of human resources and funding.

4.3.1 - Documentary Research

The documentary research aimed to discover and develop the relevant issues for this research. The documentary approach was also used in other studies on parks. For example Bon Tempo (1994) used a management plan in order to gain information about the park biophysical characteristics which are relevant for ecotourism development and to determine the socio-economic characteristics of the region. In order to examine the Jamaica's attempt to protect a tropical forest reserve, Berke and Beatley (1995) also derived data from analysis of documentary material, including protected area biophysical and socio-economic research reports, plans, agency reports and so forth.

Relevant research material for this thesis was gained from a variety of state institutions but mainly from the Forestry Institute and can be summarised as follows.

a. Documents such as management plans gave information about availability and sources of data on biophysical resources (fauna, flora, etc.) including the availability of maps. Management plans also allow some assessment of implementation

of past recommendations and suggestions. Examples of these include the identification if the recommendations to sample plots in physiognomic units, and to collect botanical data systematically on an annual basis were implemented; and if the proposed staff structure was implemented.

b. Other sources included projects, reports, official letters, technical and scientific papers for each of the areas; and studies and theses concerned with state parks, maps and newspapers. Further explanation of the sources used is given in chapter 6 and 7. From these documents it was possible to identify which programmes and research projects were available; to identify which sort of information was available and from which organisation; and to identify the nature of the problems concerned with human resources and funding. This approach also provided information about the main issues in the biophysical environment of the parks (for instance, the existence of a large area of planted exotic forest within PECJ which is proposed as an area of regeneration; or the existence of endemic mammals at risk of extinction, such as Black-lion tamarin and other threatened species such as the puma, within the PEMD).

Some of these documents were mentioned during the interviews. These included *"Programa de Pesquisa"* (1984) (CESP-IF agreement for develop studies in PEMD), and the report *"Formulário-Identificação: Parque Estadual de Campos do Jordão"* (1992), which contained information about the human resources available in the park and an inventory of the equipment available.

The documents were also used to generate interview questions, to supplement interview data and to cross-check the interview material. For example, from the report *"Formulário-Identificação: Parque Estadual de Campos do Jordão"*, it was possible to confirm two key observations:- firstly, the high degree of function deviation; and secondly, the existence of large numbers of personnel in labouring positions, with low-skill backgrounds.

The documents were collected from: the central agency of the parks; the library and publishing sector of the Forestry Institute (IF); the map archive of IF; the park offices; the SMA library and its sector of publications; the DEPRN-SMA map archive; and in other government organisations which are involved with collection of environmental data in the State, such the CESP document and map archive, IBGE publication sector and library; the library of UNESP campus of Presidente Prudente. It was also possible to look at the aerial photographs archive and the hard copies of satellite images available in the IF.

Thus these documents provided information on the physical location and characteristics of parks; on environmental impacts; on parks legislation; on the kind of studies being developed in the parks; and on park agency organisational and institutional characteristics. They also provided material for an historical-institutional analysis of the parks, information about current human resources constraints, financial and information management issues, and other relevant, miscellaneous information concerned with management issues in the areas.

4.3.2 - The interviews

a. Selection of informants

The selection of people to be interviewed in this study was based on the key-informant approach, which is a procedure for collecting data by choosing informants according to the level of detail they can provide (Spradley, 1979). As McCracken (1990) notes it is more important to work longer and carefully with a few people than more superficially with a large group. One of the advantages for this approach claimed by Burgess (1982) is that:-

> *'Key informants not only provide detailed data on a particular research setting, but also provide the researcher with introductions to other informants and to other situations.'* (p. 77)

The managers were the obvious initial key informants in the parks. The managers were chosen because they could provide a high level of detail and an overall view of park management in the specific parks. In their studies about park management threats in the neotropics, Tchnell et al. (1983) and Amend and Amend (1992) adopted managers as key-informants. As Honigman (1973, in Burgess, 1982) states, the selection of key informants can be based on opportunism when the informants are utilised for the special knowledge that they possess. Thus the subsequent key informants were selected based on the value that they had within the specific park context. Key informants were also identified from documents like projects and management plans in this area. For instance the researchers who worked in the research programme CESP-IF were identified in the document *"Proposta de Programa para implantação de Pesquisa"*. They provided information about the work they produced, on the organisational arrangement; on the availability of information on the park resources and the need for co-ordination of research in the area; on the problem of parks being underused as scientific field laboratories; and on the context and problems faced by the programme and the need for continuity of that work.

Other key informants were identified by the researcher who stayed in the parks and was able to establish further contacts. Facility to stay in the parks and to revisit them enabled the research to be more interactive than it might otherwise have been. Tchnell et al. (1983) and Neumann and Machlis (1989) recognise the limitations of conducting studies with key-informants at only one point in time. This includes variation on the informants' perception of problems. In such situations, this theses dealt with the problem by re-addressing the particular issue later in the interview or during a follow-up interview in order to clarify the position, which, in a single-survey approach, is not possible.

Contacts were established with personnel working in the central agency office (DRPE/IF), including technical and also personnel from other Divisions such as Dasonomia and DFEE, which were involved with ecological studies, with management plan elaboration and study, visitor data collections and research concerned in the case-study.

b. The Open-ended Interview

Open-ended interviews were adopted as the primary method of collecting information. This method has been used by Bon Tempo (1994) in developing studies concerned with ecological tourism in Caparaó National Park in Brazil using park managers and researchers as key-informants. Nepal and Webber (1995) also adopted it as a primary data collection method for studying the local people and park relations in the Royal Chitwan National Park (Nepal), which were conducted with park staff and village headmen. Berke and Beatley (1995) derived their study data on Jamaican protected areas from in-depth interviews with key informants, representatives of government organisations, domestic NGO and others, and they also cited many items of documentary material such as research and plans relevant to their research.

The Open-ended interviews were carried out in order to obtain information and cross-check data gathered from the documents and observations carried out previously. One of the first observation was that the park (PECJ only) charged an entrance fee. The examples of questions used during the interviews are summarised in Appendix 4.1 and 4.2.

The interviews lasted around thirty minutes to one hour, and in some cases whole mornings or afternoons. Some of them were repeated in different contexts so that points were clarified. Furthermore, long periods spent in the parks and return visits created a number of friendly relationships with potential interviewees and enabled access to be obtained from key documents and plans. Both managers of

PEMD and PECJ were interviewed, and also two ex-managers of PEMD. Four lower-level key staff (those contracted as rangers or labourers who were performing middle-level functions) were interviwed, 2 in PECJ and 2 in PEMD. Two clerks of PECJ were interviewed. Two guards of both parks were contacted. Interviewees were also conducted with researchers involved (past or present) with studies or projects in the area, 5 in PEMD and 3 in PECJ, as well as trainees from universities working in the parks, 3 in PECJ and 1 in PEMD. Other key-informants based in the central agency were also contacted (mainly from DRPE, but also from Division of Dasonomia and DFEE). Some of them have been involved in studies and data collection- vegetation, fauna, visiting and so on- in the specific parks and/or in other areas (5); with database management system introduction (3); with international funding administration in the IF (1). The staff of Project OLHO VERDE was also interviewed (3). Two persons from CINP were also contacted (a data system analyst and the Director of Departamento de Estudos de Projetos e Pesquisa- DEPP). An interview was also conducted with an ex-PqC of Forestry Inventory Section of IF.

Interviews with managers were carried out in their office, and both managers lived within the parks. Further information was gained at conferences, mail, and in more informal social environments such as in restaurants, managers' and staff members' houses.

4.3.3 - Observation

In addition to documentary research and interviews, information was obtained through observation in each of the research areas. Since, it was possible to stay at different times in the areas, it was possible to see the organisation of work and to observe the current infrastructure and operation of the park, visit the area with staff, and speak informally with them. This practice was particularly important in PECJ as it

was initially an unknown area to the author. In this way, observation helped to identify potential informants.

The author participated in fieldwork in PECJ with the park manager and IF research trainee in doing a preliminary survey of potential areas for opening visitor trails. It was also possible to go to a local environmental seminar held in Campos de Jordão town together with the PECJ manager. A log of the interviews and observation was kept throughout the research period. The interviews and observations were registered in diaries (nine notebooks and two letter blocks). This procedure enabled the interviews to take place in a trusting and friendly environment. Furthermore, the possibility of staying in the park for long periods enabled contacts to be visited several times. Therefore, this can be seen as adopting an approach to the research based partly on participant observation which consequently allowed an exploration of the situation and context beyond one point in time and in relation to different people and activities.

As Bryman (1988) notes, one of the major strengths of participant observation is that it is not a single method, but can embrace different ways of gathering data and can allow one data source to be corroborated or followed up by another.

4.4- Final Remarks

The strength of qualitative research is its flexibility in gathering data, i.e., the facility of data collecting at different time periods, without time constraints, and the open-ended format in conducting interviews with various informants which maximised the information gathered.

Close contacts with personnel helped to establish a good rapport with them, which enabled access to more specific information from the managers and staff of these two parks. This assisted access to documents and other relevant information. The ability to be in touch with manager and staff at frequent intervals over a

considerable period of time helped to build positive interaction with them. The establishment of a good working relationship proved to be one of the great strengths of this research project. As Borman et al. (1986) note, the direct involvement of the researcher with key informants and other participants in the research sites constitutes one of the most important strengths of the qualitative research paradigm.

CHAPTER 5

The Institutional Characteristics of the State Parks of São Paulo

5.1- Introduction

This chapter aims to present a brief characterisation of the organisation in charge of state parks in São Paulo. The Forestry Institute (IF) is the main agency in charge and it is subordinated to the State Secretariat of the Environment (SMA). This chapter also broadly examines problems related to human resources and the funding issues faced by this agency in the administration of parks.

It also identifies the role and problems concerned with international environmental funds for conservation management. These issues are discussed in order to identify the potential problems of funding allocation to parks management.

5.2.- The Forestry Institute: The State Parks Agency

IF is the agency in charge of state parks in the State of São Paulo. This institution belonged to the State Secretariat of Agriculture and Food (SAA) until the creation of the (SMA), when it was transferred to the new Secretariat in 1986 (Figure 5.1). At present the Forestry Institute administers about 3.4 % of the State land. Most is a network of parks and equivalent reserves -*"Unidades de Conservação"* (Table 5.1), which is under the responsibility of the Division of State Reserves and Parks- DRPE (Figure 5.1).This land also includes a small group of areas for research on potential economic uses of planted forest-*"Unidades de Produção"*, composed mainly of exotic trees such as *Pinus* and *Eucalyptus*, which are under responsibility of the Division of Forests and Experimental Stations- DFEE (Table 5.2).

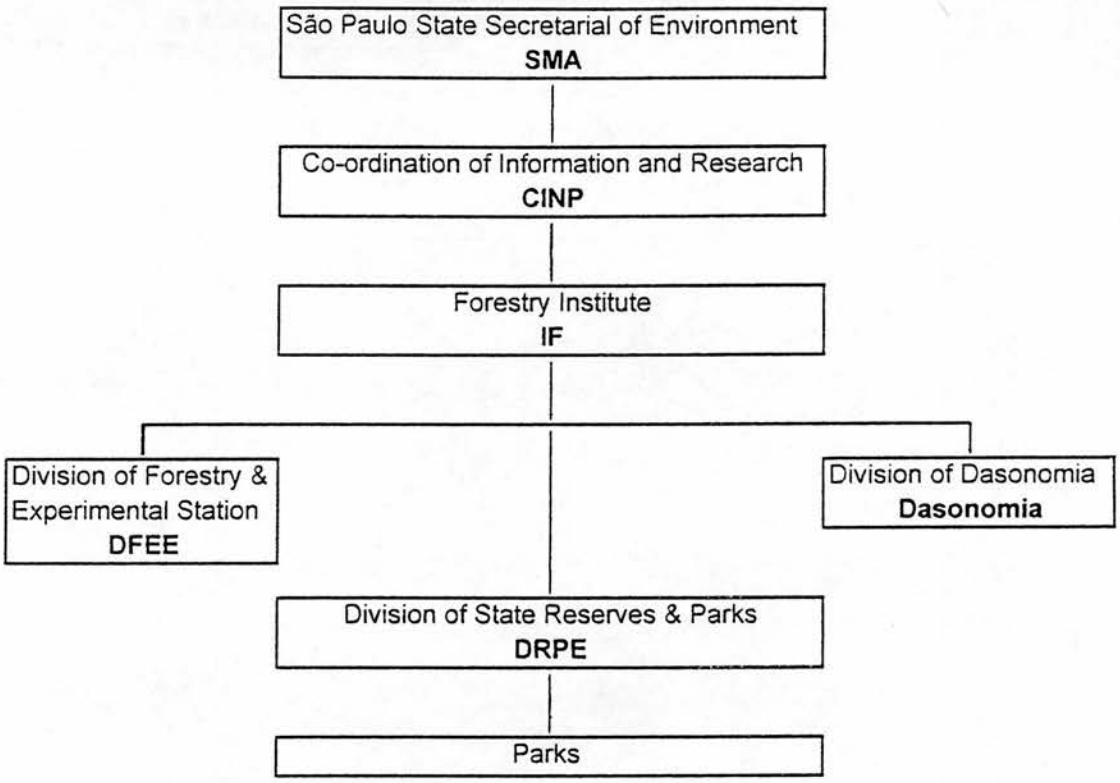

Figure 5.1- Organisational structure in which state parks are embedded

Table 5.1 - Parks and Protected Areas administered by IF

State Parks	Area (ha)
1. Serra do Mar	309,000.00
2. ParqueTuristico do Alto Ribeira	35,156.33
3. A.R.A.	64.30
4. Campos do Jordão	8,385.89
5. Parque da Capital	174.00
6. Ilha de Anchieta	828.08
7. Ilhabela	27,025.00
8. Ilha do Cardoso	22,500.00
9. Jacupiranga	150,000.00
10. Jaragua	492.68
11. Vassununga	1,732.14
12. Carlos Botelho	37,644.36
13. Morro do Diabo	33,845.33
14. Porto Ferreira	611.55
15. Furnas do Bom Jesus	2,069.06
16. Cantareira	7,000.00
% of the total area of São Paulo	2.6%
State Reserves	**Area (ha)**
1. Aguas da Prata	48.35
2. São Roque	23,900.00
3. Lagoa São Paulo	13,343.00
4. Morro Grande	10,700.00
% of the total area of São Paulo	0.19%
Indigenous Reserve	**Area (ha)**
1 Itariri	1,212.47
% of the total area of São Paulo	0.005 %
State Ecological Stations	**Area (ha)**
1. Bananal	884.00
2.São Carlos	75.26
3. Itabera	180.00
4. Itapeti	89.47
5. Xitue	3,095.17
6. Ibicatu	76.48
7. Bauru	287.98
8. Valinhos	16.98
9. Caetetu	2,178.84
10. Chauas	2,699.60
11. Jatai	4,532.18
12. Paulo de Farias	435.73
13. Ribeirão Preto	154.15
14. Moji Guacu	980.71
15. Santa Barbara	2,712.00
16. Itirapina	2,300.00
17. Angatuba	1,394.15
18. Itapeva	108.77
19. Santa Maria	113.95
20. Jureia-Itatins	79,270.00
% of the total area of São Paulo	0.41%
Total %	**3.2%**

Source: Information about size of the state protected areas was obtained from IF, 1990.

Figure 5.2- State parks and protected areas under IF administration.

Source: IF, 1992.

Table 5.2- Production Areas administered by IF.

Production Areas	Number	Area (ha)
Experimental Stations	21	36327.86
State Forestry	10	13,661.94
Tree Nurseries and like	07	3,165.77
	Total	53,155.57
	% of the total area of São Paulo	0.2

Source: IF, 1990.

The IF, through the Division of State Reserves and Parks (DRPE), is the principal institution concerned with the administration of parks and equivalent protected areas at the state level[1]. There are other government agencies in charge of a few state reserves and parks, but they play a smaller role as these areas represent in total only 0.02% of the State land. Some of these are part of the SMA and some are part of other State Secretariats (Table 5.3). There is only one National Park and two small Ecological Stations in the State which are administrated at national level by the Federal agency Brazilian Institute of the Environment (IBAMA).

Table 5.3: Other agencies involved in parks and equivalent protected areas administration in the State.

Agencies	State Parks and Equivalent Protected Areas	Area (ha)
IBt- SMA	Biological Reserve of Mogi Guaçu	467.00
	Biological Reserve Vila Fachini	70.00
	Biological Reserve Serra Paranabiacaba	336.00
	State Park Fontes do Ipiranga	549.31
FF-SMA	Fazenda Intervales	38,000.00
	Ecological Park Monsenhor E. J. Salim	110.00
DAEE-Secretaria de Obras	Ecological Park of Tiete	1,400.00
	State Park Nascentes do Tiete	2,000.00
Instituto de Zootecnia-SAA	Biological Reserve Andradina	168.00
	Biological Reserve Sertãozinho	720.00
IAC- SAA	Biological Reserve Pindorama	537.60
	Total	6,359.91
	% of the total area of São Paulo	0.02

Source: DEPAN, 1989.

[1]Areas designated as State and Federal Parks are restricted in use to scientific, cultural, educational and recreational purposes and are created and administrated by the State and Federal government respectively. State and Federal Reserves are areas where all activities are prohibited, with the exception of scientific activities duly authorised by the authorities (see IUCN/WCMC, 1992).

5.3- Human Resources and Infrastructure Issues within DRPE-IF: a general view

The parks and protected area network under IF responsibility has increased over the last 20 years, but the number of staff in the IF has not grown by similar proportions (Figure 5.3). The Director of DRPE[2] noted that the demand for services has increased due to park growth, but the staff has been reduced nearly by half. This identifies a further problem inhibiting the management of the State Parks and equivalent Reserves, which is the increasing shortage of staff.

Though the parks have been receiving more attention than ever before, due to the growth of world interest in the environment, there have not been sufficient government resources to cope with the growth of the parks network and with the needs of an appropriate management. The situation of human resources of the DRPE is one of the most difficult issues in the management of parks, in São Paulo:-

> *'The complex situation of the human resources team involves not only shortage of personnel, but also presents serious problems concerned with the form of contracting, with salaries, with the lack of career plan and with function deviation. It is necessary to contract urgently a further 959 staff.'* (DRPE, 1992, p. 9)

The inadequate human resources policy is therefore a critical issue. There are not only insufficient numbers of staff, but other organisational problems such as function deviation due to the lack of adequate personnel, and the lack of regular training programmes further exacerbates the human resources problem (aspects to be considered further in Chapters 6 and 7). A critical point is concerned with training continuity:-

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[2] Interview in december of 1991.

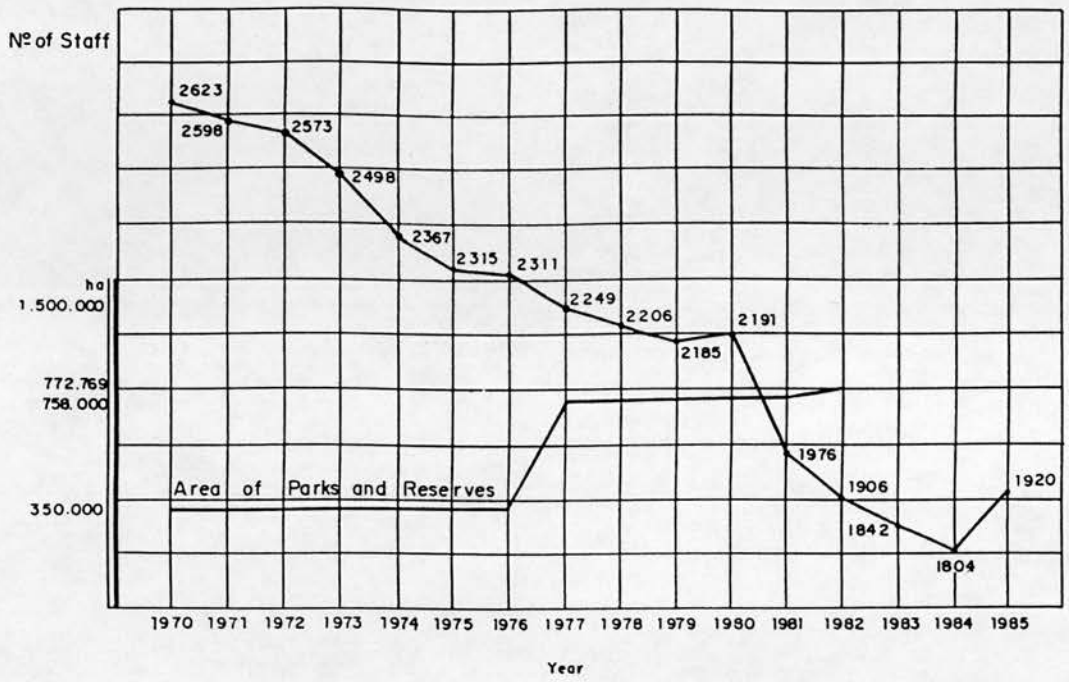

Figure 5.3- Relationship between the growth of the parks and equivalent protected areas network and the number of IF staff[3].

Source: FF, 1986.

[3] By the end of 1991 the number of staff was reduced to 1513 (information obtained from the Director of Departamento de Estudos de Projetos e Pesquisa- DEPP/CINP of the SMA, 1992). This decrease is due to the fact that retired personnel have not been replaced by IF. Furthermore, in 1995, the temporary staff hired by FF and all staff of Baneser were laid off due to a new government policy concerned with reducing public expenditure. The actual area of parks and equivalent reserves under IF administration is about 790,000 ha. IF is also in charge of a planted forest area of about 53,000 ha.

'At present there is not a regular and continuous programme for training and re-education of personnel involved in the implementation of the protected areas'. (DRPE-IF, 1992, p.9)

The numerous human resource bottlenecks within the Division of State Parks and Reserves may be summed up (see DRPE-IF, 1992) as follows:-

1. The size of parks and protected areas under DRPE responsibility is 764,430.58 ha and there are 788 people to perform the tasks of protection, implementation and management of these areas. Therefore the proportion is about one person per 1000 ha.
2. The low salaries and a general lack of adequate conditions are not conducive to the minimum performance necessary to complete the required tasks.
3. There is a significant function deviation in most areas of staff employment.
4. The staff of DRPE at several levels have limited access to opportunities for training and re-training through courses, congresses and seminars.
5. There is a lack of prospects in terms of career improvement and where a career plan exists it does not produce concrete results.
6. There are many different forms and conditions of legal contracting and staff are contracted from different organisations such as by FF, IF, CETESB.

The above points provide a critical picture of human resources problems facing state parks. The various forms of legal contracting of staff within parks and reserves are severe problems in the present situation. Because of the lack of institutional alternative (IF is not allowed to contract in consequence of a government policy for the centralised administration), there have been non-permanent staff contracted (19,3%) who are contracted month by month (DRPE-IF, 1992). This precarious contracting situation is occurring in parks such as State Park of Campos

do Jordão, PETAR, Ilha Anchieta, Cantareira, Serra do Mar and Ecological Station Jureia-Itatins (DRPE-IF, 1992). The contracted posts include guard, co-ordinators of programmes, and even administrators responsible for the administration of the areas as the case of the Ecological Station of Juréia-Itatins and PETAR (DRPE-IF, 1992). Furthermore, change in state government administration lead to the cutting of personnel contracted as non-permanent staff by FF and contracted by agencies such as Baneser (this former agency was closed by the new state government in 1995). About 400 members of the DRPE staff were laid off. Thus discontinuity and changes in political-administrative orientation are further problems to the implementation and operation of parks. The success of parks as a conservation management category depends much upon continuity.

Another serious situation is that of the researchers who also have to cope with overlapping administrative and managerial functions within the parks. The personnel contracted permanently by IF are made up of researchers, who represent 21,27% of the staff with university level qualifications (DRPE-IF, 1992). However, though they have a career plan, salaries are low at all levels. The PqC (Scientific researchers of São Paulo State Research Institutes, which include the Forestry Institute-IF) have suffered an outstanding salary loss and are earning much less than their counterparts in State Universities (USP, UNESP, UNICAMP) who have also had salary losses over the last two decades [4]. The PqC-6, the highest level in the Institute researcher hierarchy, earns about 65 % of the MS-6 salary, their State University counterparts[5].

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[4] See Official letter of three the State Universities associations to the State Universities Council *Carta aos Membros dos Conselhos Universitarios das Universidades Estaduais Paulistas e do Conselho deliberativo do CEETPS*, São Paulo, abril 1995, Adunesp-S.Sind., Adunicamp, Adusp-S.Sind., Sinteps, Sintunesp, Sintusp, STU which show that in 1994, the highest level of University remuneration is about 25% in relation to 1975.

[5] Information obtained from official letter sent out by Mr. Antonio Carlos Pimental Wutke, President of the APqC, to the Exmo. Sr. Dr. Mario Covas, Governor of State of São Paulo in 17/04/1995.

This is not encouraging, particularly considering that researchers of DRPE have to carry out both administrative and research functions. Administration of parks in Brazil is not an easy task, as managers have to face strong pressures such as shortage of financial, human and material resources; inadequate or inappropriate land use practices from neighbours; land tenure problems; opposition and lack of comprehension from local governments and a population that lacks environmental consciousness; illegal mining and vegetation extraction, hunting, visitor pressure, pollution, and in some areas the presence of native populations. Thus the career of a researcher faces complex problems of administration and difficulties for further improvement. Furthermore, research assistants face similar problems, particularly of low salaries and the lack of prospects. Thus the lack of an adequate salary policy is a notable problem.

There are also staff contracted through CLT by CETESB, FF and IF. There have been some cases of personnel who were not included in a career plan within their organisation for more than eight years (DRPE-IF, 1992). This kind of problem can hinder any other further organisational improvements as personnel become discouraged.

In order to carry out the activities of implementation, administration and management of the state parks, the DRPE have limited numbers of vehicles. This situation is most aggravated by the fact that 60,3% of available transport is more than 5 years old and the problem is worsened by lack of a continuous flow of financial resources for routine maintenance (DRPE-IF, 1992).

In summary, chronic shortage, inadequate training of human resources and the unstable sources of finance are major impediments to adequate management of the State parks and equivalent protected areas. The difficult and unstable situation of park personnel does not appear encouraging for further organisational developments such as the implementation of new technology such as example GIS. Such a development

would require more specialised staff. These issues are potential problems for the successful introduction and use of GIS technology. Constant changes of personnel and in the political-administrative direction are further problems for parks management.

5.4.- Establishment of SMA in the State of São Paulo

The UN's Conference on the Human Environment, held in Stockholm in 1972, was a key political event in the history of international environmental concern. This conference emphasised the need to allocate resources specifically to environmental issues (Ros Filho, 1994). It established the United Nations Environment Programme (UNEP). Environmentalism grew during this decade, and many non-governmental organisations were created. In Brazil, some initial institutional solutions were attempted to improve environmental management. One example is establishment of the Federal Secretariat of the Environment (SEMA), in 1974. However, it was a powerless and isolated agency, with inadequate human resources and financial support. As Nefussi (1989) notes, government concern with the environment was rather a political reaction to the Stockholm conference than a government priority. Currently, organisations as SEMA, IBDF and SUDEPE are integrated into the single body IBAMA, but the lack of human resources persists. In the 1970s, the first plan for a protected areas system was presented by IBDF, the agency responsible for national parks and protected areas administration (IBDF, 1979). This resulted in the proposal of new categories for conservation management and in the creation of numerous protected areas at national and state level (IBDF, 1982; Cortez, 1991).

The following decade was important for the development of environmental awareness and of environmental organisations, both governmental and non-governmental. In 1981 the National Environmental Policy was issued. In 1984 the State of São Paulo launched its State Environmental Policy. In the late 1980s the

National Congress reformulated the Constitution. The environmental legislation was much improved. At the State level the Constitution was reviewed and many references to environmental issues were added[6]. The forestry code received improvements which created more effective means for the punishment of illegal hunting and fishing.

Several NGOs were established in the late 1980s. As Loureiro (1992) notes, the improvement in the democratic political scene contributed to the expansion of environmental NGOs[7] and to some strengthening in their political influence. During the 1980s the NGO SOS Mata Atlantica was formed in the State of São Paulo, and this played an important political role in the issue of conservation of the Atlantic Forest. One of the most significant actions of the environmental NGOs was the campaign in defence of the Juréia region - one of the best preserved stretches of remnant Atlantic Forest in the State of São Paulo. This campaign involved promoting events and petitions for conservation of this area (Loureiro, 1992). This resulted in the creation of the State Ecological Station Juréia in the area where it has been planned to site two nuclear power stations (Iguape I and II) as part of the Brazilian nuclear programe. NGOs such as SOS Mata Atlantica have also been promoting acquisition of information about the general situation of natural forest in the Atlantic Forest region through a joint project with the Space Research Institute (INPE) and with the support of private companies (see Fundação SOS Mata Atlântica, 1992; 1993). Thus NGOs have played an important role in the growth of environmentally orientated political action and in improvements in environmental policies and in changing the actions of government institutions. The mention of Atlantic Forest in the Brazilian Constitution as an area of national importance (*Patrimônio Nacional*),

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[6]For more information see the special edition about environmental issues in the State Constitution: *O Meio Ambiente na Constitutição do Estado de São Paulo* in JornalECO from October, 1989.

[7] There are more than 700 NGOs all around Brazil, the most important ones being mainly concentrated in São Paulo and Rio de Janeiro States (Loureiro, 1992)

owes much to the activities and lobbying of NGOs which also contributed to the creation of the Green Party (*Partido Verde*) and to the election of deputies committed to conservation issues. The growth of democracy could therefore be argued to have helped to foster a growing recognition of the importance of conserving remnants of natural resources such as the Atlantic Forest.

In 1986, the Secretariat of Environment (SMA) of the State of São Paulo was established. It has been subjected to changes since then, but it basically incorporated several agencies and departments involved with management, protection and research of natural resources. The present structure comprises four co-ordinating bodies. IF was transferred to this Secretariat, and it is subordinated to the Co-ordination of Information and Research (CINP).

The SMA incorporated some agencies, councils, normative bodies and departments of other Secretariats. These include the Company of the Technology of Environmental Sanitation (CETESB), the Forestry Institute (IF), the Institute of Botany (IBt), the Institute of Geology (IG) and the State Department for the Protection of the Natural Resources (DPRN) from the Secretariat of Agriculture and Food, State Environmental Council body (CONSEMA) and, the Coastal Defence Committee (CODEL). The formation of the SMA, a political project of the state government of Franco Montoro, was an attempt to integrate and improve co-ordination among institutions involved in environmental planning and management, in order to co-ordinate efforts for implementing environmental policy. There was overlap of responsibilities between government agencies involved with environmental and conservation management. For instance, environmental licensing usually led them to take decisions according to individual points of view and self interest, sometimes contradictory and opposite to each other (Guillaumon and Ogawa, 1985; Café, 1989). But even within SMA there was some overlap. With SMA creation, a Department of Parks and Natural Areas (DEPAN) was established to administer some of the state

parks and equivalent reserves in the coastal area, which was paradoxical as there was an agency, IF-DRPE, responsible traditionally for the management of most parks. Eventually, in 1991, it was incorporated in the Forestry Institute.

The creation of SMA was supposed to lead to a more integrated approach to environmental management. Nevertheless, the parochialism of the existing institutions incorporated into SMA seemed to be causing problems to real integration. The project OLHO VERDE[8] undertook the inventory of natural vegetation of the State between 1988-1989 with participation of IF in part. But in 1993, IF published an Atlas of the natural vegetation and reforestation without the participation of the Project OLHO VERDE (see Kronca et al., 1993). The letter published in the JornalEco from IF[9], and the answer to that, show idiosyncrasies between these two bodies which should be working together as part of an environmental system of the State. This presents further problem for real integration.

The simple creation of an environmental institution does not mean that environmental policy and strategy can always be applied effectively. Political commitment, social support, manpower and financial resources are all required. Furthermore, competition for resources and power makes the development of an integrated environmental sector extremely difficult. Additionally, rigidity of bureaucracy and centralisation is a further problem to an efficient administration which has been leading to the proliferation of environmental foundation agencies[10].

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[8] In 1988, DEPRN started the Project OLHO VERDE in order to have updated information of natural vegetation to give support to surveillance. It aimed to provide updated maps of natural vegetation of the State and to initiate a monitoring system based on satellite imagery and GIS tools. The first stage was to map the whole natural vegetation of the State using satellite images (colour composition of bands 3/4/5 in paper and in scale 1:50000). The project acquired in-house GIS software (SIG/SITIM) from FUNCATE-INPE in 1990, this organisation also provided the training.

[9] The letters section of *JornalECO*, march, 1991, p. 2. The tittle of the IF member letter is *'Quanto sobrou das nossas matas'*, and in the same section there is an answer in *'Nota da Redação'*.

[10]Foundation Agencies such as FF are not private agencies and are not part of the centralised administration system. Rather they are part of the decentralised administration structure. Then allow

However this solution has not always been so successful. An example of this issue is presented by Libório:-

> *'The creation of parallel bodies, generally foundations, has been a common alternative adopted as an attempt to improve the mandate of existing agencies. The creation of the Forestry Foundation of São Paulo is an outstanding case. This agency was established in order to make the work by the Forestry Institute more efficient, however this alternative was not sufficient. As a result the Department of State Parks and Natural Areas -DEPAN was created (Decree n. 33.135/SP), in the Secretariat of the Environment, with a mandate to administer the state parks and ecological stations.'* (1994, pp. 306-307)

This brief discussion suggests that true integration and co-operation inter-agency has yet to be achieved. The contribution of the creation of SMA to the establishment and management of parks and equivalent protected areas is, as yet unclear. SMA is still a weak sector in terms of government priority. Between 1987-1990 the state government invested from about 9 to 12% of state budget in the Secretariat of Transport and from 0.2 to 0.7% in the Secretariat of Environment (SEADE, 1992). In 1994, the government investment in these two Secretariats did not change, i.e., the Secretariat of Transport received about 9.5%, and the government allocated 0.7% to the Secretariat of Environment (SEADE, 1994). The lack of resources is reflected in the slow implementation of proposed actions and strategies, which are also subject to administrative and political changes. Parks in the coastal areas, which were nearly abandoned, have been waiting for a long time to have projects implemented on infrastructure for public use:-

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a more independent administration system avoiding the centralised and bureaucratic difficulties of the Brazilian public organisations. Unlike IF, FF can manage its financial and human resources with some autonomy of centralised control and rules.

'On the Ilha de Anchieta and in PETAR the construction of Visitor Centres has been delayed for one year, without a deadline to finish due to the difficulties of resources and in sorting out the budget and financial problems with Secretariat of Financial Affairs.' (DRPE, 1992, p. 34)

Among the actions proposed in the State of São Paulo Environmental Policy (Consema, 1984), are park and reserve land consolidation (State Park of Alto do Ribeira, State Park of Serra do Mar- Cubatão e Picinguaba areas, Ecological Station of the Juréia), the establishment of a Information System for coastal monitoring, the dissemination of data about water quality, and improvements in access to the environmental database and to information relevant to the State. Nevertheless, there is a gap between rhetoric and action. The process of land ownership consolidation is slow, no adequate budget is allocated to carry it out and for maintenance, and land tenure is still an unsolved problem in the public protected area of the State. In 1984, IF proposed a 3-year plan (see Castanho, 1984) to consolidate the land ownership in the state park areas (*Proposta de Política Florestal para o Estado de São Paulo - Plano Emergencial*), however, a new plan (*Plano de Ação Emergencial: Implantação e Manejo de Unidades de Conservação*) shows that land tenure situation is much the same (see DRPE-IF, 1992). Furthermore, the limited government budget for maintenance and operation of the parks is a critical issue for adequate management (see DRPE-IF, 1992).

Shortage of government financial support is a well known difficulty within Brazilian environmental organisations. Therefore, external financial sources are tremendously important to agency work. The State of São Paulo Secretary of the Environment[11] recognises the need to develop means of acquiring external resources from both foreign and private sources. In the particular case of the administration of parks and equivalent reserves, the State Secretary emphasises the importance of

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[11] Interview with the Secretary of the Environment of the State of São Paulo to *JornalEco* n.2, vol. 13: O Papel do Estado, april 1991, p. 4-5.

seeking the co-operation and participation of the private sector. As Ros Filho (1994) notes, this alternative should be explored and could be an alternative to the dependency upon foreign financing. Klabin[12] also argues that financial resources for conservation should be found from internal sources. The NGO Fundação SOS Mata Atlantica has been developing a Joint project to map changes in Atlantic Forest cover, in the States of Paraná and São Paulo States, with support from private companies such as Klabin and Metal level (Fundação SOS Mata Atlântica and INPE, 1992; Fundação SOS Mata Atlântica, INPE and IAP, 1993). Nevertheless, integration between private sector and environmental agencies, both governmental and NGOs, has still to be achieved. The majority of the national private sector tends to be *"....guided by easy profit, and is socially and environmentally irresponsible"* (Ros Filho, 1994, p. 17).

The institutional difficulties pertinent to the international funding of the environmental sector are discussed in the next section.

5.5- External Funding for the Environment: Perspective and Constraints

The growing pressure of the international environmental groups during the 1980s led donor agencies such as the World Bank, to look more carefully at environmental factors within the context of their investments in developing countries. Environmentalism influenced the international political context, resulting in the incorporation of environmental and conservation issues in project planning and in Federal and State constitution.[13]. An example of this concern in development projects is the more careful attitude of CESP in relation to the impacts of the dam construction

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[12] R. Kablin in Munhoz (1992).

[13]See *Constituição da República Federativa do Brasil*, Art. 225, pp. 146-147 (1988). See also 'O Meio Ambiente na Constituição do Estado de São Paulo' (*JornalEco*, October, 1989).

in the State Park of the Morro do Diabo -PEMD (see Chapter 6). The importance of the preservation of ecosystems such as the Mata Atlantica and the Costal Zone, and the need for a sound utilisation and management of their resources were mentioned in a specific article (number 225, paragraph 4-'Chapter VI - of the Environment') in the Brazilian Constitution. As consequence, a decree prohibiting deforestation of natural vegetation in the Atlantic Forest was created on 10th February, 1993, based on that specific article which was concerned with the Pantanal, Costal Zone and the Atlantic Forest[14].

The 1980s were particularly important for the development of the environmental organisations. In Brazil, the existing environmental management agencies (SEMA, IBDF and SUDEPE) were integrated to form the Brazilian Environmental Institute of Renewable Resources (IBAMA). In São Paulo, SMA was created in order to strengthen and harmonise the State's environmental sector. However, continuing lack of staff training and financial support jeopardises the development of this institutional project. The environmental sector faces organisational and institutional problems similar to those of other government sectors, notably lack of financial support, low earnings, loss of qualified personnel and lack of administrative continuity. The lack of government financial support is worst in this sector in comparison with development sectors such as that of transport. Furthermore, the investments in the latter sector are particularly centred on road transport which is heavily dependent on petrol (Apeosp, 1995).

In 1990, the Federal Government established an agreement with the World Bank in order to implement the National Programme of the Environment (PNMA)-see Table 5.4. This was the first large programme to be funded by international agencies (Ros Filho, 1994).

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[14]See *Diário Oficial*- Decreto N. 750, de 10 de Fevereiro de 1993.

Table 5.4 - The PNMA: A World Bank-Brazilian Government Agreement.

Institution	US$ Million	%
World Bank	117.00	70.00
Government	33.10	20.00
KfW	16.30	10.00
Total	166.40	100.00

Source: Document of Brazilian Government (1993) in Ros Filho, 1994.

The PNMA has three principal objectives: to promote organisational development and to strengthen environmental agencies; to improve the protection of the existing protected areas, and to implement the legislature for new areas; and to improve the management systems of endangered ecosystems such as the Pantanal, Atlantic Forest and Coastal Zone (Ros Filho, 1994). However the development of PNMA programme has faced tremendous bottlenecks. Ros Filho (1994) points to a series of institutional problems that are constraining the success of this programme. Inflation is one of the most serious problem for external investment [15]. Foreign investment has to be converted into the national monetary value, for budgetary planning. This value is not adjusted to the inflation index, which is very high and unstable. Therefore, the initial value of the investment is reduced due to the inflation rate (see Table 5.5).

Table 5.5 - PNMA budget loss for the year 1992.

Period	Exchange rate Cr$	US$	%
Jan./1992	2406.55	55.70	100.00
Dec./1992	11500.00	11.60	20.80
Total Loss %			79.20

Source: based in Ros Filho, 1994.

[15]Presently the inflation situation has been changing due to the new economic policy established in the mid 1994s (*Plano Real*). The rate of inflation of about 40% came down to 3% per month. However, many structural changes are required to make it sustainable in the long term (see Como ficam os salários?, in *Exame*, v. 28, n.14, p.146, July 5, 1995 by José Marcio Camargo).

Ros Filho (1994) pointed out another series of institutional problems which are influencing the successful implementation of the PNMA and therefore the effective use of the available foreign investment:-

1- according to Brazilian legislation, the transference of financial resources to state administration is only possible if the state or municipal governments are not in debt to the Federal government. This restriction prevented many States from access to funding for a long period;

2- the State and municipal governments have to put up a 30% counterpart to obtain the Federal investment;

3- the transference of the funding to the State can only be done every 3 months, and bureaucratic procedures waste further time. Moreover, the investment can only effectively start in the second term of the 'civil year' (i.e. January-December), which means in effect April, therefore wasting the first three months;

4- lack of adequate structure in IBAMA (the agency created at the time that the agreement was established, and which was chosen to administer the programme in Brazil), and lack of experience of both IBAMA and other environmental agencies involved in the implementation of programmes financed by WB;

5- the political and administrative instability of IBAMA.

The duration of the programme was intended to be three years, from 1991-1993. However, up to July 1993, less than 10% of the budget had been expended, due to the innumerable problems that caused delays in programme execution (Ros Filho, 1994). The lack of counterpart financial resources to carry out projects is one serious problem to the use of WB money. Shortage of human resources is also an obstacle for State parks of São Paulo, such as for instance Jacupiranga, to use the investments of WB by through PNMA (see DRPE-IF, 1992). This agreement with WB was

temporarily cancelled at the end of 1993 due to the difficulties from the Brazilian part[16].

The agreement between state government and KfW started being negotiated by 1989, but due to changes in government there were many changes in the team responsible for agreement execution and many alterations in the project proposed for the state parks and reserves. As a result of government discontinuity, it was only in 1993 that the contract was assigned; furthermore, recent changes in government caused a reduction in the team in charge of the project for the parks[17]. Thus structural bottlenecks make difficult and slow down foreign investment in parks.

Another critical point is shortage of human resources, in number and quality, which make it difficult to receive international funding, since personnel are unable to operate and carry out projects. The human resource issue is threatening the ability of state parks to receive investments from KfW:-

> *'The proposed investment of the Conservation Project of Tropical Forest-Mata Atlantica by KfW in 8 State parks and equivalent protected areas for 1993, may not be viable due lack of human resources'.* (DRPE-IF, 1992, p. 45)

KfW has strict regulations which require that there be adequate personnel before investing in equipment. For example, in order to provide funds for the acquisition of X number of cars, this agency requires X number of personnel contracted specifically as drivers[18]. This is a problem, as 'function deviation' has been a quite common practice within park management (DRPE-IF, 1992). Furthermore,

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[16] Information obtained from interview with a member of the technical staff of SEPLAM (1994).

[17] Information provided by a member of the technical team representing the IF in the agreement with KfW (1995).

[18] Interview with the PEMD park manager and with one of the member of the team representing IF in the KfW agreement (1995).

the allocation of resources financed by this agency is directed towards implementation of parks from coastal areas which excluded investments in parks such as PEMD and PECJ considered to be in a better situation[19]. Furthermore, 50% of the funds provided by KfW have to be paid back, which adds to the state debts.

Another problem pointed by Munhoz (1992), during the *Congresso de Essências Nativas*, is that foreign funds arriving for conservation activities in Brazil are directed to the Amazon region, when the most threatened ecosystem is the Atlantic Forest. This preference by donor agencies is also stressed by Ros Filho:-

> *'Despite an increasing interest of the international donor, the support to projects is geographically and topic restricted. Foreign resources have mainly been provided for activities in the Amazon Region, and for conservation of natural resources sensu stricto.'* (1994, pp. 30-31)

In terms of conservation funding for protected areas, NGOs such WWF have been contributing in the late 1980s, particularly in projects of environmental education and training in the State parks. Yet, funds were distributed among so many parks and other protected areas that each received very little. In 1989, WWF provided 7000 US$ for programmes of environmental education in the State protected areas, which was applied to 14 projects[20]. This amounted to 500 US dollars for each area, including PEMD and PECJ. Obviously this was an important contribution for a sector which has been receiving meagre resources from the government, although the distribution of funds may not have been very effective. Additionally, international money gets devaluated when it reaches the parks due to the long bureaucratic process and inflation[21]. Klabin (in Munhoz, 1992) notes that foreign contributions have

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[19] Interview with the PECJ park manager and with one of the member of the team representing IF in the KfW agreement (1995).

[20] Information obtained from JornalEco in *'Verba do WWF para a SMA'* n. 7, Dec. 1989, p.14.

[21] Interview with the PECJ manager (1992).

usually been distributed between too many organisations resulting in small amounts for each of them.

> *'There has been international funding for the environment but in small bits, here and there. Additionally there are bureaucratic constraints to receive this money. Furthermore, WB is usually at odds with Brazilian governments.'* (1994)[22].

Therefore, it is concluded that although there has been international funding for the environmental sector, there are strong institutional impediments to its successful use such as inflation, rigidity and centralised bureaucracy, lack of adequate human resources and the political-administrative instability of IBAMA and of the environmental State agencies.

5.6-Summary

DRPE-IF is the agency in charge of most of the parks and equivalent protected areas in the State of São Paulo. However, the existence of this organisation did not save the natural resources of the State from near total destruction. Lack of financial support, and inadequate political commitment to conservation issues, in particular with regard to parks and protected areas, caused reduction in natural forest cover. The most significant continuous area of natural vegetation remaining is located in the most mountainous area of the State, in the coastal region mountain range '*Serra do Mar*'. In this case, the survival of the natural vegetation from the pressures of economic development owes more to topography and climate than to well defined conservation strategies. Currently it is designated under different categories of conservation management and most of the area is under park category.

During the 1980s, the organisation of the environmental sector in the State greatly improved as consequence of World environmental movements. This resulted

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[22] Interview with a researcher who worked in the CESP-IF-FBCN project within PEMD (1994).

in the creation of a Secretariat of Environment to integrate the different agencies involved in environmental management and regulations. However, the parks and equivalent protected areas still lack the required human and financial support for adequate establishment and management. Public funds are limited for long-term operation and maintenance particularly for training, research, interpretation and education.

In face of the shortage of financial resources, external financial support can play an important role. However, there are institutional constraints to effective use of this finance as demonstrated by the case of the PNMA and KfW. As a consequence, financial resources for protected areas have been constrained by institutional instability. Furthermore, at the present time when finance is available, the priority is implementation of the coastal parks which were nearly abandoned and are threatened by very powerful, illegal exploration of natural resources such as mining and heart of palm extraction. In the light of this political context and institutional framework, the research now turns to a detailed analysis of two case studies.

CHAPTER 6

Case Study I: State Park of Morro do Diabo

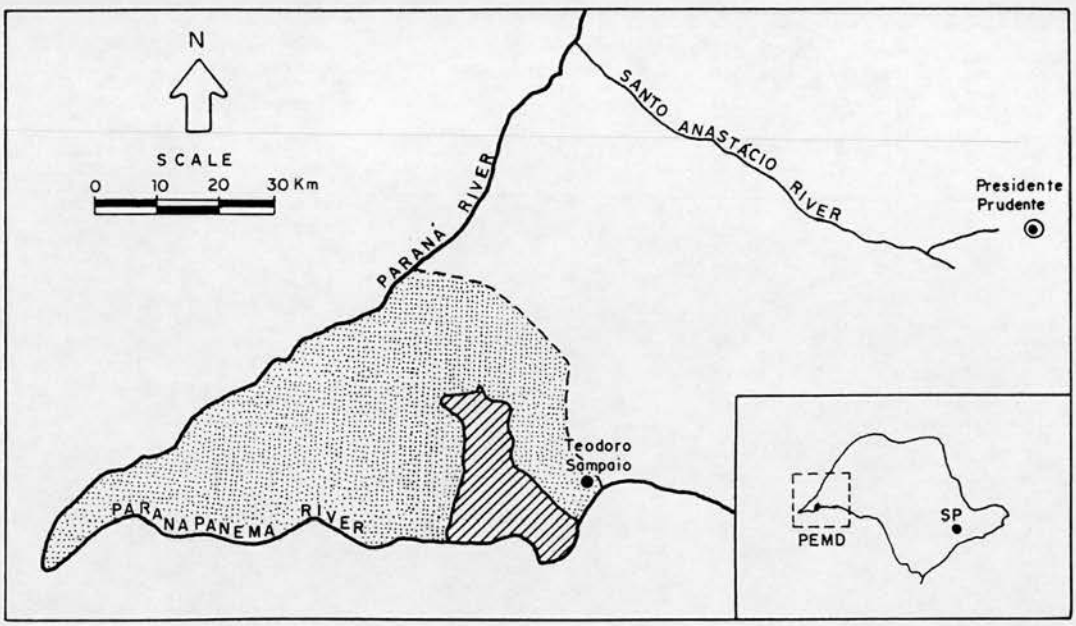
6.1 - Introduction

This chapter analyses the creation and management of the State Park of Morro do Diabo (PEMD). An historical approach is adopted in order to identify the administrative and institutional problems which the park passed through and which can still affect its management.

A geographical information system has been shown earlier to be an important tool for the management of the park resources. However, institutional factors such as political and administrative discontinuity, instability and shortage of financial resources and inadequacy of human resources are likely to put a strong constraint on the extent to which the opportunities offered by a new technology will be realised in practice. Consideration of these factors provides insight into the kinds of bottleneck that the implementation and operation of a geo-information system technology can face in State Parks. A discussion of the critical issues for the PEMD management and feasible alternatives for the introduction of information system technological support are undertaken.

6.2 - Description of the Area

The State Park of Morro do Diabo (PEMD) is an area of about 34,156.68 ha (Pastore and Berzaghi, 1989). It is located in the southwest of the State of São Paulo, in the Municipality of Teodoro Sampaio, in the Pontal do Paranapanema area, within the administrative region of Presidente Prudente (Figure 6.1 and Figure 5.2). It is about 700 km from the capital city where the park has its Central Agency- DRPE/IF. This makes it the farthest State Park in relation to the DRPE. This is one of the most



State Park of Morro do Diabo (PEMD)

Municipality of Teodoro Sampaio

Figure 6.1- Geographical situation of the State Park of Morro do Diabo (PEMD), Municipality of Teodoro Sampaio, within the administrative region of Presidente Prudente, State of São Paulo.

disturbed regions of the State, with the PEMD containing the largest significant remnant of natural semideciduous forest in the interior of the State. This park is like an oasis, bounded by a degraded landscape. So, it is of particular interest because it gives an opportunity to evaluate whether it fulfills the area concept of island biogeography (see MaCarthur and Wilson, 1967). It is surrounded mainly by large land holdings of cattle ranching, and large areas of sugar cane plantations on the northwest part of the park (Plate 6.1 and Plate 6.2). The region has been badly affected by devastating human actions such as deforestation (including gallery forest) and deliberate use of fire for pasture land management and incidental occurrence of fire during the dry season (Plate 6.3). There have also been incidence of criminal fires to destroy the natural forest and the reserves (Deshler, 1975; Leite, 1981). The human activities have resulted in severe soil erosion and silting of water courses.

Conservation of the park is fundamental for the preservation of the genetic resources of the region, particularly for endangered species. It is extremely important, therefore, to preserve and protect this remaining tract of forest, which can provide the basis for basic ecological studies as well as the for conservation management of the region. It is the only significant natural vegetation fragment operating as a significant fauna refuge in the whole of the western and central region of the State (See Figure 1.2, in Chapter 1). The general biophysical characteristics of the park are summarised in Table 6.1.

The conservation management of all endangered fauna, particularly of the black lion tamarin, depends on the preservation of the park and of the fragments of natural vegetation surrounding the park (see Valladares-Padua et al., 1990). Therefore, it is very important for the survival of the local fauna to create a buffer area around the park with corridors to link the populations inhabiting the outer small fragments to the park.

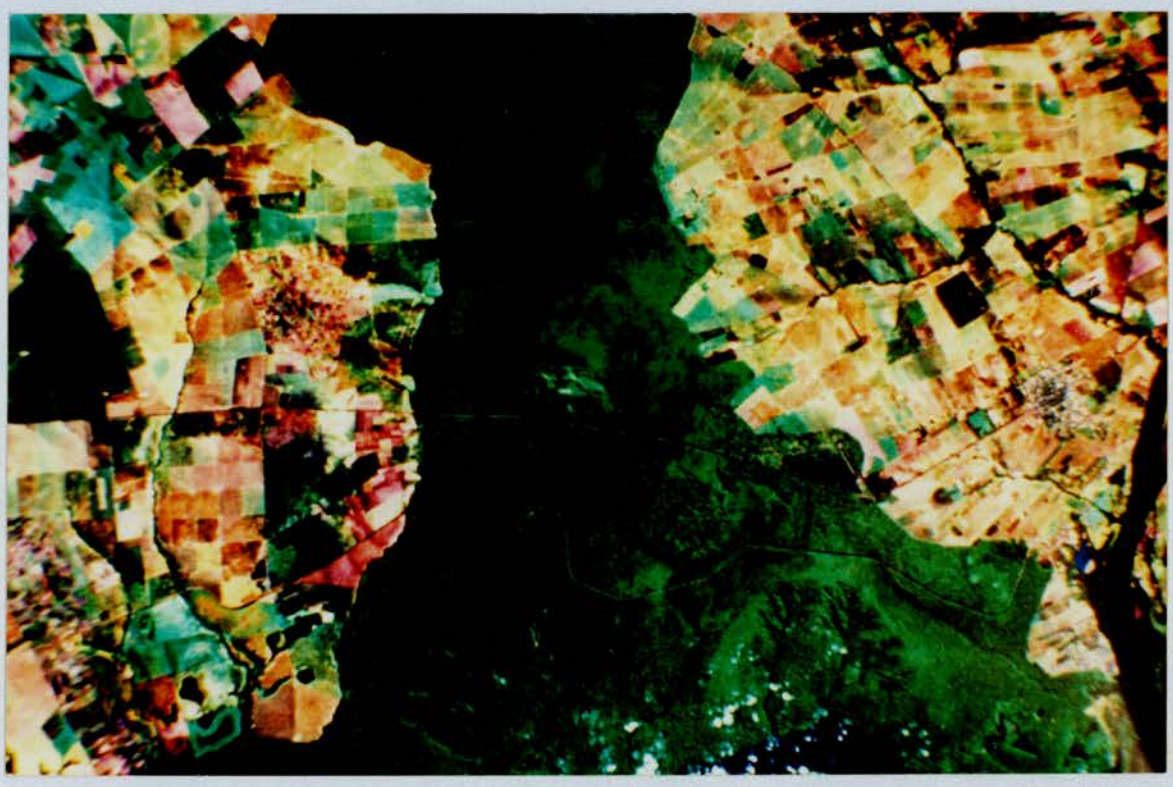


Plate 6.1 - View of the devastated landscape surrounding PEMD (TM Satellite Image from 1991).

Plate 6.2 - Pastureland-A common land use adjacent to the PEMD.

Plate 6.3 - Fire occurrence in the PEMD vicinity.

(Photo: Francisco E. S. P. Vilela)

Table 6.1- Biophysical characteristics of the PEMD.

Biophysical elements	Description
Topography and altitude	Predominantly between 300-400 m, with a small part of the area (about 2 km²) reaching 590 m known as the Devil's Hill. This hill is an outstanding and unique landscape feature in the region (Plate 6.4).
Soils	Dominantly dark red Latosol sandy phase (LEa), which is highly liable to erosion. It has low water storage capacity (Deshler, 1975)
Climate	Classified as Cwa (Köppen), with mean temperatures of over 22°C, in the hottest month, and below 18°C, for the coldest month; and mean total rainfall below 60 mm during the dry season (April-September) (Guillaumoun et al., 1983).
Vegetation	Tropical broad-leaved semideciduous forest is the predominant vegetation type. It is the largest continuous tract of forest in the interior (west and central region) of the State. Only about 30% of the forest can be considered as primary (Vilela and Faria, 1989) (Figure 6.2). Important tree species include the ipê-roxo (*Tabebuia impetiginosa*), which can reach up to 40 m height and is being studied for potential pharmacological uses; the peroba-rosa (*Aspidosperma polyneuron*), which can reach 35 m height and 2 m diameter and is used for buildings though it is presently very rare; the cedro-rosa (*Cedrela fissilis*); the cabreúva (*Myroxylon peruiferum*); the jatobá (*Hymenaea courbaril*), which can reach up to 40 m height and 200 cm diameter and produces edible fruits appreciated by the local fauna; and popular Brazilian fruit trees such as jaboticaba (*Myrciaria* sp.), are native to the region (see Vilela and Faria, 1989).
Fauna	The park is rich in mammal species, the most famous and endangered of which is the black-lion tamarin (*Leontopithecus rosalia chrysopygus*) (Bernardes et al. 1990). At present, the PEMD is the only significant habitat for this species. The park fauna also includes populations of other mammals with very reduced populations in south-eastern Brazil, such as the jaguar (*Panthera onca*), the puma (*Felis concolor*), the tapir (*Tapirus terrestris*), the red howler monkey (*Allouatta fusca*), the pecari (*Tayassu tajacu*), the white-collared pecari (*Tayassu pecari*), and the coendu (*Coendu tricolor*) (Russi, 1987). The tapir is the largest native mammal found in South America. There are also many species of reptiles and birds which are threatened with extinction, such as the macuco (*Tinamus solitarius*), the king vulture (*Sarcorhamphus papa*), nearly extinct in the neotropical forests, and the yellow throated alligator (*Caiman latirostris*), which has nearly disappeared from all around the original area of occurrence (Russi, 1987). Willis and Oniki (1981) made an inventory of the bird species in 13 protected areas of the State, and found the occurrence of 185 species within the PEMD from the 425 species observed.

This park is not located in a well known tourist region, as in the case of the PECJ and EEJ. These areas received about 69,000 and 117,000 visitors, respectively, between January and July in 1992, while the PEMD received only 5,000 people over the same period (DRPE-IF, 1992). So far there is no high visitor demand, which may be due to the characteristics of the region, being neither located in an outstanding mountainous region such as PECJ and nor close to the sea and mountainous such as

Plate 6.4 - The Devil's Hill in the PEMD.

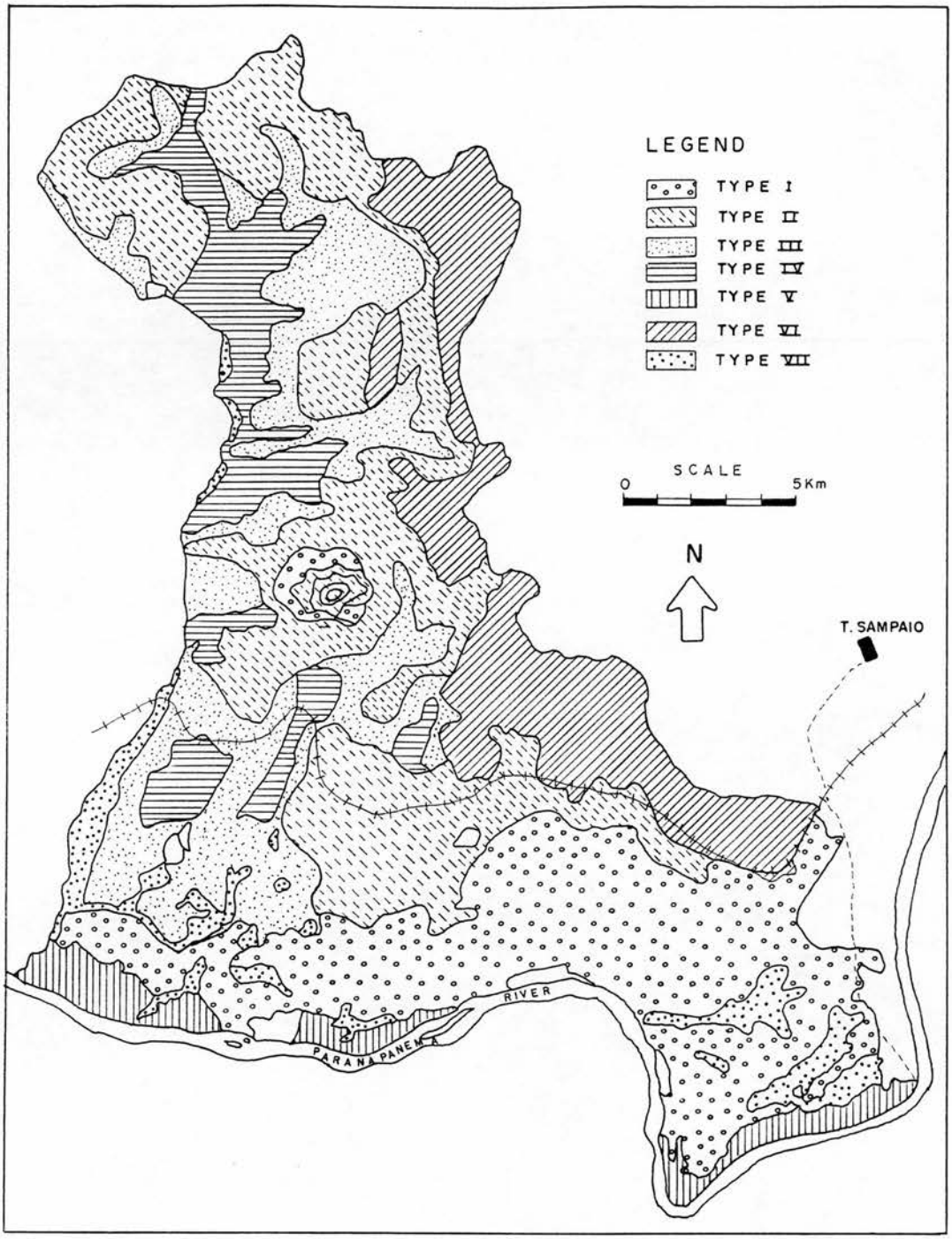


Figure 6.2 - Vegetation map of the State Park of the Morro do Diabo. Vegetation types: I. Densely stocked tall forest; II. Moderately stocked tall forest; III. Poorly stocked forest; IV. Very impacted forest; V. Heterogeneous forest; VI. Highly impacted forest fallow; VII. Abandoned pasture.
Source: Campos and Heinsdijk, 1970.

EEJ. Unlike these areas, PEMD is located in one of the most remote and under-populated areas of the State. The western region is very devastated and now presents a plain and monotonous landscape.

In summary, the Park is an extremely important remnant from the once widespread Atlantic Forest in the region, containing a variety of endangered plants and animals, which require detailed survey and study. Its especial importance lies in the fact that it is the sole significant remaining fragment of such forest in the whole west and central part of the State. Unlike the coastal region, which is covered by a continuous tract of natural vegetation, the PEMD has no connecting corridors to other forest fragments (see Figure 1.2, in Chapter 1). Thus, it can be argued that the preservation of the park is more important and urgent than any possible economic benefits which might result from its direct use, or even from indirect use, such as tourism and recreation.

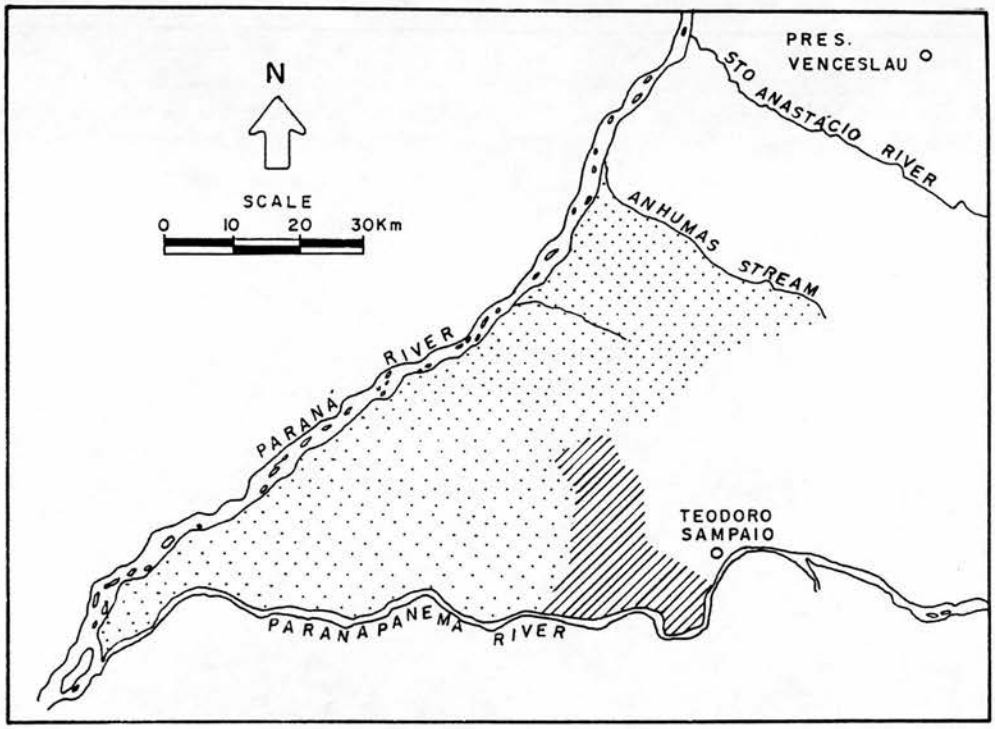
Although the focus of this research was not on public participation in the park, it was possible to identify some joint activities of park staff and local schools and local NGOs, for example the organisation of 'Environmental Week' exhibitions in Presidente Prudente (since 1992) and in Teodoro Sampaio (started in 1995), as indication of growing public awareness of and even participation in local environmental issues including those connected with the park. Furthermore according to park staff about 90% of the park visitors are school pupils. This visiting system and environmental education programme only started after the creation of park infrastructure in 1986. The development of greater public participation and wider awareness of the park's importance will depend very much on such programmes of environmental education, which have continued despite the difficulties of shortage of resources.

6.3 - The origin of the PEMD

During the 1920s and 1930s, land occupation and the creation of urban settlements in the Alta Sorocabana region spread along the railway, E. F. (*Estrada de Ferro*) Sorocabana, which was a product of the expansion of the pioneer fringe and coffee plantations (Leite, 1981). This progressive occupation in the Alta Sorocabana, brought rapid deforestation. However, up to this time the Pontal region had not yet been badly damaged, although it went through serious troubles concerning land tenure (Leite, 1981).

The Pontal of the Paranapanema was the last area to be occupied during the westward expansion of coffee plantation in the State. In the early 1940s, over 90% of the Pontal region comprised nearly untouched forest (Leite, 1981). The rapid development of the region, the contentious issue of land tenure, and the growing threats to the Pontal forests, together with the creation of National Parks in the late 1930, all influenced the State Government to create the State Reserves in the Pontal. In 1941, the decree n. 12.279 created the first Reserve of the State: the 'Reserva Estadual do Morro do Diabo' in what was then the municipality of Presidente Venceslau. This area of 37,156.00 ha had been declared unoccupied government land since 1934 (Leite, 1981). In 1942 was created the Grande Reserva do Pontal (246,840.00 ha.) adjacent to the Reserve of Morro do Diabo.

However, in his seminal work about the process of land occupation in Pontal do Paranapanema, Leite (1981) shows that the lack of commitment from subsequent governments with the implementation and management of these reserves nearly resulted in the elimination of the natural vegetation in the Grande Reserva do Pontal, the largest in the region, and in the degradation of the remaining vegetation of the State Park of Morro do Diabo (for the past situation see Figure 6.3 and for the actual situation see Figure 1.2 in Chapter 1).



Morro do Diabo Reserve

Grande Reserva do Pontal

Figure 6.3- The boundaries of the reserves Grande Reserva do Pontal and Morro do Diabo at their creation in the early 1940s.
Source: Leite (1981).

After the creation of the reserves in the Pontal, Jânio Quadros was the only governor who took conservation actions with respect to the Pontal reserves (Leite, 1981). These included a request to the State Agency IGG (Instituto Geográfico e Geológico) to carry out a airphotogrammetric flight (scale 1: 20,000) in order to assess the reserve's cover by mid 1950s, improvements in the local forestry policy, and the construction of a house for the park guards. However, this governor's conservation measures did not have the support of subsequent state governments (See Leite, 1981). The situation of abandonment of Morro do Diabo only started to improve in the mid 1980s due to the construction of the reservoir of Rosana and to the pressures of growing environmentalism which will be discussed in the next section.

6.4 - Morro do Diabo: lack of resources, degradation and the perspectives brought by the Reservoir Project.

By the late 1960s, the state of forest conservation in the Pontal Reserves was not encouraging. Although the forest reserve of the Morro do Diabo was better protected than the other two reserves, the resources of the Forestry Service, the agency responsible for the management of this area, were severely limited. After being occupied and commercialised since 1950s, the area was still a victim of fire caused by human activity, either intentional or not. This situation was aggravated by the lack of sufficient personnel to carry out the protection service (Secretaria de Economia e Planejamento do Estado de São Paulo, 1978). There was an inadequate infrastructure of buildings, cars, trails and fire suppression equipment to cope with basic daily operations for protection and management (Deshler, 1975; Leite, 1981).

This situation of virtual abandonment and lack of commitment to conservation was obvious. A flagrant example was the case of a Sergeant of the local State Forestry Police who invaded the area in the late 1960s and was using it himself for

agriculture and cattle ranching[1]. During the land reform carried out in the 1980s by the government of Franco Montoro (1982-1986), landowners suggested to the government that the lands of Morro do Diabo Reserve could be given to landless people, instead of having to divide 'their' lands. Many of these 'landowners' were already occupying government lands in the Grande Reserve of Pontal (Leite, 1981). The second largest fragment located in a private farm near the PEMD (Tucano) was taken by the government for settling landless people in part of it. This occurred after the conservationist wave in the late 1980s for the salvation of the PEMD and for black-lion tamarind. Recently it was suggested by a member of the ITESP (Institute of Lands of the State of São Paulo) that the park degraded area known as *Sapezal* (a weed grass) to the east of the park should be given to landless people[2].

The crucial factor which contributed to change the desperate situation of the PEMD was, strangely enough, the development projects proposed by the State Government for the Pontal do Paranapanema in the 1970s, particularly that involving the construction of the Pontal Hydroelectric Power Stations (HEPS). In the early 1970s, the CESP (Electricity Company of the State) initiated studies to locate the dam building areas and three reservoirs were proposed: Taquaruçu (504000 kW) and Rosana (320,000 kW), on the Paranapanema River, and Primavera (1,814,400 kW), on the Paraná river (Figure 6.4). The Rosana Reservoir was predicted to flood about 3000 ha of the most important and ecologically significant area of the PEMD, along the Paranapanema River (see Deshler, 1975; Leite, 1981; Serio et al., 1984), corresponding to approximately 12% of the park area.

By 1978, the State Secretariat of the Economy and Planning launched the *'Programa para o Desenvolvimento do Pontal do Paranapanema'* (Secretaria da Economia e do Planejamento do Estado, 1978). The projects, among which were the HEPS, were seen as a source of employment, involving specialised and manual

[1] Interview with a park ex-manager (1991).
[2] Information from interviews with the park manager and a researcher of CESP (1995).

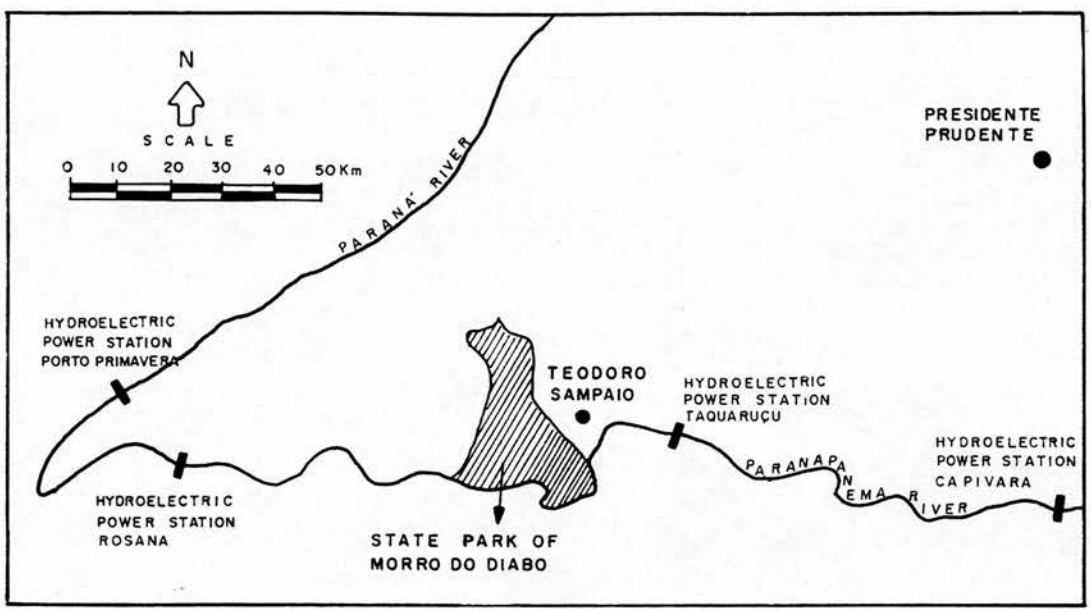


Figure 6.4 - Location of the Hydroelectric Power Stations in relation to the PEMD.

labour. The Programme showed some concern for environmental conservation, by mentioning the need for the implementation of a management plan in the Morro do Diabo and for the demarcation of the Lagoa São Paulo reserve. The programme also recommended the improvement of the IF budget and increases in personnel in order to implement the park policy. It pointed out that the budget shortage was the main obstacle to the implementation of a management plan.

Despite these recommendations, it was only in the mid 1980s that concrete actions were taken into effect to implement the necessary structure for protecting and managing the Reserves. However, the creation of a more adequate infrastructure for this area was only possible after the CESP-IF/SAA agreement, which settled the payment of expropriation for the part of the park land that would be flooded by the Rosana Reservoir.

The benefits for the Pontal parks, particularly the PEMD, caused by the reservoir initiatives were actually a result of the increasing pressures from environmentalists during the 1980s. It was decided that the resources derived from the expropriation would be invested specifically in the PEMD and not elsewhere[3]. It is likely that if the HPS had not needed to flood part of the park area, not much of the park situation would have changed. It was a common conclusion among the interviewees[4], that the resources provided by the CESP-IF agreement contributed enormously to the improvement and establishment of the park infrastructure. This resulted in the construction of buildings, trails and particularly by the acquisition of equipment such as cars, boats, and those for fire prevention and combat. Furthermore, the circumstances also forced the government to allocate a budget to the IF in order to contract more personnel for the Park. Furthermore, the main source of financial

[3] Information provided by interviews with researcher of the CESP-IF Programme (1995).
[4] Information provided by the manager and ex-managers of the PEMD, by researchers in the CESP-IF programme and managers of other areas (1991, 1992, 1994, 1995).

resources for maintenance of cars, equipment and even contracting student trainees has been mainly based on the agreement budget (nearly finishing).

6.5 - Gains in conservation after the CESP-IF/SAA Agreement

In 1970, the black-lion tamarin (*Leontopithecus chrysopygus*), a highly threatened primate species (Bernardes et al., 1990) was rediscovered in the PEMD, after 65 years without sightings (see Coimbra Filho, 1976). That was the only known population large enough to be considered genetically viable (Sério, 1986). However, it did not appear in the studies and zoning proposals (preliminary) developed in the *Recomendações Para o Manejo do Morro do Diabo* by the FAO forestry officer William O. Deshler (Deshler, 1975).

It was not until the CESP-IF/SAA agreement was established that this endangered species really achieved attention. The precarious human and material resource situation of the park before this agreement is described by Leite:-

> *'As a matter of fact, it had only five guards when the Director of the Reserve considered that 32 would be required, in order to contain the illegal invasion of the forest, as well as the fire hazard coming, quite often, from the adjacent pastureland. On the other hand, the Forestry Police located in Teodoro Sampaio had 4 guards, who had the mandate to charge the illegal forestry users, but did not have any vehicle to make the necessary inspection.'* (Leite, 1981, p. 246)

This situation of near abandonment of the area was also emphasised by the manager, who mentioned the lack of adequate administrative staff until the establishment of infrastructure and transformation in State Park[5] in the mid 1980s, which was a consequence of the agreement between CESP-IF[6]. Because of its severe

[5]Unlike reserves, parks have recreation as one of their main objectives. As there is a local interest in developing tourism in the Pontal Region, it seemed more appropriate to designate this area as a park than as a reserve. Additionally, PEMD is the only protected area and large natural vegetation remnant in the region.

[6]Information from the park manager (1992)

budget constraints, the IF usually depended very much on external funds obtained through agreements with other institutions such as JICA (Japanese International Co-operation Agency)[7]. However, it seems that this agency had invested mainly in the projects and studies in the planted forest within Experimental Stations rather than in the ecology of natural forestry of the parks. An example of that is the investment of JICA in the project of mechanisation developed in the planted forest within PECJ (for more detail see next chapter).

The agreement between CESP and the Forestry Institute (CESP-IF/SAA), which belonged to SAA (State Secretary of the Agriculture and Food) by that time, was firstly established for five years, from 1984 to 1988. The payment of US$ 730,000 (Cr$ 734,769,000.00) for park land expropriation was invested to implement an infrastructure for administration and research in the area, and it has been used for maintenance of the Park[8]. The agreement resulted in the acquisition of vehicles, boats, boat engines, etc. A residual funding from CESP payment of US$ 58,000 (Cr$ 986,000.00) was provided in a new agreement between 1990-1995. However, according to decisions from top DRPE managers, this fund was divided among six other areas administrated by the IF, including the Reserve of Caetetus where a smaller population of black-lion tamarin is found[9]. The amount ascribed to the PEMD was by no means enough for a period of five years[10].

The park staff was considerably increased over the CESP-IF agreement period. Around 62% of the existing park personnel were contracted between 1986 and 1988. These included guards, one manager and one researcher. This was the first

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[7] Interview with a ex-staff PqC - researcher of Forestry Institute (1992).
[8] These values were taken from an interview with the park manager who obtained this information from IF documents in the central agency (1994).
[9] Interview with the park manager who has worked since 1986 as researcher, and since late 1991 as manager of this area.
[10] As the person responsible for education and guiding visitors has left, the park manager was using CESP funds to pay a university student trainee as replacement. Information provided by the park manager and the trainee (1995).

time that the PEMD had a manager and a researcher specifically working and living in the area. These personnel were contracted for 2 years and then incorporated to the IF staff.

Other equipment and facilities acquired during this period included vehicles, boats and equipment for fire suppression[11]. About 61% of the park vehicles presently available were purchased between 1986-1989 with budget provided by the agreement SAA/IF-CESP[11]. In addition, accommodation was provided for researchers and students, administration buildings were constructed, a zoological museum for the local species was developed together with a reasonably equipped conference room. Finally, two trails for the interpretation and environmental education programme (the Morro trail and the black-lion tamarin trail) were also established.

This agreement, and additionally the joint project with IUCN/WWF/FBCN, provided resources to develop ecological studies and projects in the area to be flooded by the reservoir. The major ecological project concerned studies on the black-lion tamarind and involved researchers from the IF and Department of Environment/CESP. However, this joint programme faced numerous problems in coordinating personnel from different institutions. Some of them left it before finishing the projects[12].

The IUCN/WWF-US provided international support for this endangered species. WWF-US designated funds for the project entitled *'Further survey work and development of a preliminary management plan for the endangered golden-rumped tamarin (Leontopithecus chrysopygus) in the Morro do Diabo State Reserve'* proposed by R. A. Mittermeier in 1982, to be developed in the Morro do Diabo. The funds were administrated by FBCN (see Sério, 1986; Sério et al., 1984). This project

[11] From a document organised by Vilela (1992), the park manager, presenting records of human and material resources of the PEMD. This includes the sources which provided the material resources, and information about the resource situation. This information is part of an Administrative Information System organised by the park central agency.

[12] Information obtained from interview with a researcher from CESP-IF-FBCN programme (1995).

was developed by the agreement, with participation of experts from IF, CESP, IUCN and the national NGO FBCN, which administrated the capital provided by WWF (see Sério et al., 1984; Serio, 1986; Pastore and Berzaghi, 1988; Carvalho et al., 1989).

The priority of the project was to study the flora and fauna of the area of the Park which would be flooded by the reservoir, including the fauna to be rescued and re-allocated. In 1984 a meeting of experts from the three agencies involved (IF, CESP and FBCN) defined the research priorities. They presented a document *'Proposta de Programa para Implantacao de Pesquisa'* (Sério et al., 1984). Two projects were proposed to be developed in the then State Reserve of the Morro do Diabo, in two stages:

(1) *'Vegetation of the State Reserve of the Morro do Diabo'*, with two sub-projects, *'Vegetation Mapping of the State Reserve of the Morro do Diabo'* and *' Flora of the State Reserve of the Morro do Diabo'*.

Sub-project 1- aimed to update the vegetation map of the State Reserve of the Morro do Diabo, which was carried out by Campos and Heinsdijk in 1970, using photo-interpretation in aerial photos, flight CESP 1977/78, at a scale of 1:20,000 and base map 1:50,000 (IBGE). The vegetation map updating was carried out for the zone planned to be flooded, but not extending to the whole Park. It was based on aerial photographs from 1978.

Sub-project 2- aimed to gain further knowledge of the phytosociology and flora aspects, through quantitative and qualitative vegetation surveys. It was supported by US$ 9,600.00 from FBCN/CESP.

As a result, a group composed of the three agencies was organised to carry out flora and phytosociological surveys between 1984-1986 (see Baitello et al., 1988; Pastore and Berzaghi, 1989). These were developed in the area planned to be flooded. However, the sample units which were not under the lake are lost as they are not geo-referenced, and the trails used as reference to access them are mostly under water

now. Furthermore, a CESP researcher mentions that it was very confusing to decide about the sampling method to use.

(2) *'Fauna da Reserva Estadual do Morro Diabo'.*

This aimed at obtaining knowledge of the fauna of the State Reserve of the Morro do Diabo (abundance and correlation with the habitats), emphasising mammals. However the black-lion tamarin was the only mammal to be studied in detail. About US$ 6,200.00 was invested in this project. This resulted in studies such as *'Aspectos da bionomia do mico-leão-preto (*Leontopithecus chrysopygus, *Mammalia, Callithricidae)'* (Carvalho et al., 1989), located in the expropriated area to be submerged by the lake. Further studies on the tamarin resulted in a post-graduate Ph.D. project (Valladares-Padua, 1993) developed in the University of Florida, *'The ecology, behaviour and conservation of the black-lion tamarin* Leontopithecus chrysopygus, *Mikan, 1823'* by a researcher who was temporarily contracted by the CESP/FBCN/IF programme. Apart from these, no other detailed study about park fauna was produced.

However, after the initial studies developed by the joint project, there was no further research cooperation between IF and CESP researchers. From that time on there has not been any other joint project nor even any individual study by CESP Department of Environment. CESP could be an important investor in the park in terms of financial and human resources for research of fauna. At the same time, changes in government have been causing heavy cuts in human and financial resources for CESP, seriously affecting the Environment Department. From a figure of 23 staff working in the wildlife management section in Teodoro Sampaio only six remained in 1995, so this is not a very encouraging picture for the moment[13]. Yet the local sector of CESP has equipment (such as tracking radio and GPS) and some expertise in the

[13] Information from an interview with a reseacher of CESP (1995).

study of mammals, particularly the howler monkey (*Allouatta fusca*) and jaguar (*Phantera onca*)[14].

So far, no phytosociological studies and monitoring programme has been carried out in the park, including its more degraded areas. Apart from the phytosociological survey in the flooded area, the only existing research consists of a small experiment from a Ph.D. thesis inside one of the best preserved vegetation area (see Schlitter, 1990). There have been some attempts to implement an experiment for regeneration in a sample unit of the most degraded area of the park but it has not been continued and neither of the plots were geo-referenced[15]. Thus there are bits and pieces of ecological studies which require to be organised into a more systematic framework for long-term monitoring. Furthermore, it is necessary to geo-reference and to standardise methods of collection of information in order to allow for monitoring and comparison and therefore to allow for more advanced data manipulation.

It seems that the IF interest in the black-lion tamarin has disappeared following the formation of Rosana dam. There is no monitoring programme being carried out in the park, and the black-lion tamarin research experts of the IF are no longer working in the area. An NGO, IPE, based on Piracicaba City has been working with the black-lion tamarind, but only in the fragments outside the PEMD. Thus, although there was a great enthusiasm over the joint work with CESP/FBCN, it requires continuation and a fresh injection of funds and initiative. Although there were difficulties of working with many different agencies, the agreement showed that lack of human resources and shortage of government financial resources for parks can only

[14] According to an interview with a researcher from CESP who is expert in fauna, CESP is developing studies with these three species in the areas affected by the HPSs in the Pontal do Paranapanema region.

[15] Information obtained from an interview with an IF researcher and PEMD ex-manager (1995), who attempted to implement an experiment on the regeneration of a degraded area in the park in its eastern sector. This project was not carried out after he left the park in 1991.

be overcome through joint efforts and co-operation. This requires commitment to conservation issues and to overcome parochial and individual idiosyncrasies.

6.6 - Management problems of the PEMD

6.6.1 - Financial issues

Although changes in the global attitudes during 1970s and 1980s favoured the growth of environmental awareness and pressure for the creation and protection of parks and protected areas, improvements in the infra-structure of the PEMD were more a result of dam construction rather than from the efforts of environmental lobbies. However, the international environmentalism did have an influence on the allocation of resources for the PEMD. CESP provided resources for fauna rescue and re-allocation by participating in a project for reduction of environmental impact of the reservoir on park fauna, and for developing studies together with IF/FBCN-WWF. The CESP had created a department of environment in 1970s, with a wildlife management sector located in Teodoro Sampaio. However, only pressure from the international and national environmentalist movement forced CESP to give support to reduce the effects of the reservoir and compensate for the land taken. The reservoir nearly caused the extinction of the black lion tamarin whose best preserved habitats were located in the area due to be flooded. This impact would have created a negative image for CESP. In the early 1980s, a researcher of IF called international attention upon this fact by contacting an expert in primates (Mittermeier) who was that time president of WWF. At the time WB was financing the construction of the hydroelectric power station of Rosana and because of international pressure it was halted. Thus, CESP not only paid for the expropriation of the park land but participated in a joint programme (Sério et al., 1984) for studies, planning and rescue

of fauna, and for attention to ensure removal of trees before the formation of the reservoir, but also gave the required human and financial support[16].

However, this financial resource is now divided among other areas, and was about to finish in September 1995. Furthermore, due the economic crisis within CESP as consequence of the new government policy (heavy cuts of resources in government resulting from the huge State debts) payment of the final quotas has been delayed[17]. This is causing serious concern to the manager, because the government budget for parks is too meagre for basic parks needs. For instance, maintenance of vehicles has been depending much upon CESP agreement for resources.

The CESP-IF agreement was extended for a further 5 years from 1990 due to the availability of residual funds resulting from the first stage. However, this budget, as decided by the top managers of IF, had to be shared amongst another six protected areas administrated by IF[18]. Additionally, it has been used to pay student trainees to replace personnel who were visitor guides. Nevertheless, the manager of the PEMD is extremely concerned about the Park future. Recent change (beginning of 1995) in State government administration has reduced the CESP budget which has been delaying the payment of park agreed resources since then[19]. In 1995, all funding that PEMD received was about US$ 0.60 per ha. in monthly basis, including staff salaries[20]. A gardener charges about US$ 16,00 to clean up an urban plot of land in the city. Therefore, biodiversity is still undervalued.

This element of uncertainty in the management is understandable, considering that the infrastructure of the Park was implemented and is maintained mostly with resources provided by the CESP-IF agreement. Without the budget coming from this

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[16] All the above information was provided by a researcher who participated of the joint programme and project between IF/CESP/FBCN-WWF (1995).
[17] Interview with the park manager (1995).
[18] Information obtained from an interview with the park manager (1992/1995).
[19] Information obtained from the park manager in the first semester of 1995.
[20] Data calculated by the park manager. He also added that the average for all the state parks was about US $ 0.25.

agreement the park will have problems with maintenance and operation of infrastructure. For example, the newest car is from 1989, so vehicle depreciation is a further difficulty in the middle and long-term. Thus, the main problem of this park is not concerned with infrastructure but with maintenance and operation. The very tight government budget arrives monthly and covers only basic items such as consumables (e.g., gas, spare parts, stationery materials etc.). This budget is too meagre for adequate conservation measures, and additionally it can not be used for acquisition of capital goods such as computers, engines, cars, binoculars, computer parts etc. According to public administration regulations the acquisition of capital goods requires a long bureaucratic and centralised process. For example, the boat engine took about 6 months to be repaired[21].

International aiding agencies such as WB and KfW (German) have been landing funds for implementation of infrastructure (acquisition of vehicles has been priority). However, it has been difficult to take advantages of such financial resources due to bureaucracy and shortage of human resources. In addition devaluation resulting from inflation has affected fund-income[22]. Furthermore the coastal parks, which were nearly abandoned and have been subject to heavy mining and illegal vegetation exploitation received priority for the available funding of above agencies. In fact, the WB and KfW funds did not include the PEMD and PECJ because they were considered to be in a better situation[23].

As opposed to PECJ, the PEMD has no resources provided by visitors as an entrance fee is not charged and the demand is small. Furthermore, if fees were charged, the resources resulting from that would return to the central agency due to centralisation. The fee charging depends upon a high-level managerial decision. Seeds

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[21] Information provided by park manager (1995). There are two boats with engines, however one has no engine because it was stolen and, so far the park could not replace it.

[22] See DRPE-IF (1992) and interview with a team member representing IF in KfW agreement (IF counterpart), and with the park manager (1995).

[23] Information obtained by interviewing managers of the PEMD, PECJ and EEJ as well as an IF member in KfW agreement (1992, 1995).

of native species are collected and sent to IF, and there is no sale of plants or seeds in the park. So, this park will very soon have to depend solely upon the government budget which is too meagre for the needs of basic operational management. Furthermore, bureaucracy and centralisation is an organisational characteristic which makes it difficult to operate parks in terms of acquisition and allocation of financial resources and to develop research studies. Information and any available research input is centralised in Forestry Institute in São Paulo city (the researchers are working either in divisions of Dasonomia, DRPE and also in DFEE). Additionally, the available IF research team is not sufficient to cope with the taxonomic inventory and studies of the State Parks biodiversity[24]. IF researchers have also been having difficulties to have funds and vehicles to carry out fieldwork in the parks. This situation is aggrieved by the researcher's low-salaries who are discouraged to develop research projects.

One of the difficulties related to the use of government budget is the slow bureaucratic and centralised process to access such resources. The manager stated in an interview that if a vehicle is out of action, it is first necessary to obtain an estimate of repair costs, then to send a document requiring resources to the central agency. It can take several months to receive the required fund[25]. He goes further saying that such process may be returned to ask for clarifying points more than once, and additionally there is the risk that it will be denied alleging lack of resources. Meanwhile the vehicle stays out of use. A recent example is that there is no boat for surveillance of the large River of Paranapanema passing by the PEMD, as the engine is broken and there is no adequate budget for repairing; furthermore, the engine of another boat was stolen and there are no funds to buy a new one[26].

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[24]Information provided by the park manager and researchers in the area, as well as from PECJ (between 1992- 1995).

[25]Interview with the manager (1992).

[26]Interview with the manager, and confirmed by a park guard (1995).

Allocation of financial resources is too centralised and dependent upon top managerial decisions. Any acquisition or expenses concerned with capital goods such as building construction, vehicle acquisition and repair and equipment, demands a long and well explained procedure which should go up to the Financial Affairs Secretariat of the State (*Secretaria da Fazenda*). Acquisition of capital goods or maintenance has to follow a rigid bureaucratic procedure. This procedure is part of the centralised nature of the administration of the Brazilian public bureaucracy which makes the administration of parks very slow. It is considered a means of avoiding corruption problems. However, to some extent this is actually the excuse of the authoritarian and centralised culture of the Brazilian State clerks [27].

Furthermore, this long procedure causing delays has been bringing trouble to the providers of services, as revealed in an interview with the park manager (1992), because it takes too long to obtain the money for payment, which is fatal under high inflation. As a result, sellers are not so willing to provide for a government agency and, when they do, they usually overprice in order to overcome this problem.

6.6.2 - Human Resources Issues

The park personnel in general has a low level school background (Table 6.2). A large number of people were contracted between 1986-88, but about 81 % were unskilled low level staff[28] with no training at all in any subject and particularly untrained to carry out more specialised tasks required for management and studies of fauna and flora. These staff are mainly contracted for manual labour (collecting seeds, cleaning, driving) and as guards. However, no training concerned with protection and resources management is offered for park guards. As the park manager observes:-

> *'The guards in the PEMD are unskilled, physically unprepared and in general of advanced aged for this job. To take a similar situation in*

[27] For more information see Cardoso (1975).
[28] Information calculated based on data collected by the park manager (Vilela, 1992).

Table 6.2 - Educational background of the park personnel.

Background	Number	%
University*	4	7.85
High school	4	7.85
Primary school**	43	84.30
Illiterate	0	0.00
TOTAL	51	100.00

Source: Data calculated from records organised by Vilela, 1992
* 1 manager, 1 researcher, 2 staff performing low level function
** First 4 years (until early 1970s)

> *Argentina as an analogy, there is, in that country, a specific course provided by an agreement between the University and the Park-Guards Association to train personnel for park management tasks. So, in Argentina there is course for park guards. Furthermore, there is no such a career for park guards in our parks'.* (1992)

In Argentina there are courses for Park-Guard formation, for preparing technicians in conservation and management of protected areas, and a high-level course for planning and management of protected areas[29]. The PEMD does not even have any training and preparation of personnel for fire combat (simulations) nor a continuous training programme nor required strategies. Furthermore, even managers do not have a more specific training in the management and planning of the parks. In the case of State Parks they must have a university course level, for example the manager of the PEMD is an agronomist engineer, but he did not have to take a specific training in park conservation and management. Unlike Argentina, there is not a specific technical course for training park personnel in Brazil (park guards, planners, managers). For example, the programme of the *Fundación Universitaria Patagónica* offers courses in three different levels (see Footnote[28] in previous page). The first

[29] Leaflet from the Argentina University (*Fundación Universitaria Patagónica*) and Park-Guard Association (*Asociación de Guardaparques Nacionales de la República Argentina*). Information was also provided by the park manager who visited parks in Argentina (1994). This allowed him to see the schedule of courses and the high standard of training which Argentinean park professionals have.

level aims at training park guards (one-year course) and offers courses that have botany, soils, meteorology, ecology, fire management and combat, environmental education, computing, environmental monitoring techniques and data collection in the regular curriculum. A second level (plus one-year and a half) will prepare a technician in conservation and protected areas management and require one and a half years more of studies. A third level (plus one year) will allow the training of a high level technician in planning and management of parks to elaborate, update and implement management plan. In Canada there are also programmes for training parks staff, an example is the agreement between the Canada Parks Service and University of Waterloo (see Wilson, 1984). Therefore, the park personnel in these countries have far more opportunities to become skilled to perform tasks for conservation management than in the state parks.

In relation to shortage of training in the state parks and protected areas, a PEMD ex-manager and researcher emphasises the importance of high level training for managers as this can give him the means for a more skilled management, for instance to identify better research needs, and to use simulation of scenarios for conservation management. However, he notes that:-

> *'Unfortunately there is lack of training, planning and resources for the parks'.* (1995)

Furthermore, because of lack of skilled personnel there are low-level staff performing tasks typical of medium level requirements, such as for example, visitor guides, the ones at present were contracted in the position of manual labourer and guard (Table 6.3). This situation is not very encouraging as there are no improvements in salary[30]. Thus function deviation due to lack of qualified personnel is a further problem for management. As manager notes:-

[30]Interview with a staff who performs function different from that she was hired for (1992). This staff presently resigned from the job.

'Function deviation is a common practice due to inadequacy of personnel.' (1992)

Table 6.3 - Example of lower level PEMD personnel performing middle-level tasks.

Item	Name	Position	Actual function	Background
_____	_____	guard	visitor guide	primary school
_____	_____	manual labourer	visitor guide	high school

Source: Records extracted from data collected on human resource by Vilela (1992).

As previously mentioned, the parks and reserves usually face the problem of either shortage of personnel, or a lack of skilled people for day-to-day operations and activities of data collection in the resource aspects required for park management. Also the lack of a career plan and of positions at the medium levels (park guards, interpreters, guides, etc.) do not seem to encourage personnel in the development of more than the very basic activities. The present staff organisation structure of the parks is still based on the tradition of forestry management (agricultural and cattle raising technician) rather than on the management needs of the parks and equivalent protected areas.

It is evident that researchers and managers should have support from medium levels staff, adequately trained to perform tasks related to the park objectives of conservation and research. This staff team should involve instructors for environmental education, observers of flora and fauna, heads of programs such as vegetation, fauna, environmental education, in order to undertake the day-to-day operation and field work for studies and monitoring of the resources. However, as the park manager observes there is no such team in the state parks.

Scientific research related directly to wildlife management and vegetation resources should be oriented towards obtaining as much information as possible concerning the biology of the resources, giving high priority to endangered species, such as the black-lion tamarin. A great deal of information should be recorded on a daily or periodic basis which can be used in planning activities and ecological studies

such as, for instance, observations of wildlife and flora and fire occurrence. Thus, it is expected that the park personnel should be trained and involved with tasks established by management and research programs such as census and inventories of flora and fauna, and with periodic monitoring of populations and resource conditions. Nevertheless the personnel available in this area are only performing very basic functions of protection (surveillance), collecting seeds to send to the central agency and bureaucratic work, and there is no current systematic monitoring of fauna and flora. Furthermore, even after training these labourers and guards informally, they would not have a change in salary and career, because there is no career plan for them, only for personnel contracted as researchers.

Overlap and function deviation are problems due to human resource shortage, which is common in public Brazilian Institutions. State Parks have also been adopting this alternative, i.e. by putting personnel in functions other than that for which they were contracted. Furthermore the duties of park manager overlap with the function of researcher; researchers have to publish and research if they want to change level and thus improve salaries. Being the manager of a park only increases responsibilities without leading to career development. According to the park managers, usually managers have to do everything including sorting out problems with neighbours such as for example of problems of invasions by cattle in the park area (a kind of task which should be done by rangers), up to going to the central agency to present bureaucratic procedures for acquisition of resources a bit faster. Additionally the park manager notes that in the last two governments salaries for researchers of the Institutes, including IF, have been falling behind as never since when he starts working in 1986, which it is not encouraging at all. Present researcher salaries are about 40% smaller than those paid by State Universities for similar levels (see Chapter 5). Thus there is no incentive for being a park manager.

Furthermore it seems that it has been difficult to keep a team of high level technical staff. They have been transferring to other areas, as the present manager has done on one previous occasion, when the previous manager transferred to Paraguaçu Paulista Experimental Station. This seems to be particularly related to the fact that the area is located in a remote and isolated area of the State. Additionally the salaries are too low for the manager and even worse for the research assistants who should be skilled and have university level (about 3 times the minimum salary of the country- about US$ 400)[31]. Since the improvement of the area in 1986, the park manager has changed five times (Table 6.4). The director of the Experimental Station of Assis which is the closest area of IF to the PEMD (about 4 hours away) often has this park under his responsibility because of the difficulties in keeping a manager from DRPE there. Until 1986 there was no manager living in the park or nearby. It used to be the manager of the Experimental Stations nearest to this park (Assis) who overlapped the functions of park and experimental station manager.

Table 6.4 - Chronology of administration changes in the PEMD.

1986- Manager 1 living far from the area (Ourinhos)
1987- Manager 2 living in the area
1988- Manager 3 living far from the area and overlapping the functions of manager of the Experimental Station of Assis
1989-Manager 4 living in the area.
1991- Manager 5 (the same situation as in 1988)
1991(Dec.)- Manager 6 living in the area (who had worked as researcher in the area between 1986 and 1989).

Source: information obtained from interview with the manager (1992).

[31] Information provided by the park research assistant (1995).

Therefore, managers have changed at yearly intervals. The manager notes the problem of too many changes in local administration, resulting in confused staff members, particularly because each manager follows his personal direction. Thus, changes in park administration may imply changes in priorities and actions. This negatively affects staff formation and co-ordination and continuity of research programmes within the area. Furthermore, lack of a management plan with short, middle and long-term goals helps to create a dominant personal administration and affects continuity of management. The actions are not guided by planned strategies but by personal attitudes and caprices. Ecological studies and monitoring should have continuity. Continuity is essential for research and analysis of ecodynamic processes.

Currently, the PEMD has been using trainees paid by the CESP-IF agreement and FUNDAP to replace guides for environmental education and interpretation. This is unlikely to continue. Firstly, because the CESP agreement is about to finish and secondly, because this kind of student-contracting does not allow personnel to be retained for more than a year, resulting in consequence, in yearly changes of personnel. This presents the additional problem of new personnel being required to be trained on a early basis. Furthermore, FUNDAP is cutting fellowships due to the reduction in the government budget. Additionally the value of the salary paid to trainees is low, (i.e. the minimum salary) and they usually work more hours than the specified 20 hours[32]. Again this is a depressing picture and made even worse by the isolation of the park.

[32] Interview with a trainee (1995).

6.6.3 - Resources management and information management issues

6.6.3.1 - Resource management issues: human impacts

The impact and changes in the Morro do Diabo were caused by numerous invasions and developments, with complicity of powerful interests and politicians in the area of Pontal. The main resulting impacts are summarised in Table 6.5.

In the early 1940s, two state reserves were created in the Pontal do Paranapanema area, the *Grande Reserva do Pontal* and the Reserve of the Morro do Diabo. The former no longer exists: its natural vegetation which occupied about 90% of the area at creation has been almost completely transformed into pastureland. Although it is still legally a reserve (Decree 13.075 from 25/11/1942), it is totally under private control, and there is on-going deforestation in the few residual fragments, particularly in one of the largest and most significant fragments, known as Tucano which lies close to the park[33]. Landless people were settled in part of this forest as consequence of rural reform and they have been clearing the area[34].

The remaining PEMD vegetation is a continuos fragment of forest vegetation. Nevertheless, it is badly damaged, and it is mostly surrounded by pastureland, and by the Alcídia estate which has sugar cane plantations (about 15000 ha) and one of the largest alcohol plants in the region of Alta Sorocabana. This is a permanent threat to the park vegetation. Presently, the park urgently requires the establishment of a buffer zone to protect it from the ranching and agricultural developments (particularly adjacent plantations[35]). The Workshop Mata Atlântica, held in 1990, proposed as an emergency measure the creation of a buffer area around the PEMD and an agreement with squatters within the Park who would be given other IF lands in change for those presently occupied. However, it is likely to face strong opposition from farmers particularly those with large land holdings within the area of Grande Reserva Pontal.

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[33] Information provided by the park manager and researcher of CESP (1995).
[34] Information provided by the park manager (1994).
[35] Information provided by the park manager (1994).

Table 6.5 - The environmental impacts in the PEMD.

Activities	Description of impacts
a. Earlier land use (land speculators and logging) b. Current land use practices (mainly ranching activities and sugar cane plantations- see Plate 6.1 and Plate 6.2)	- Deforestation, burning, introduction of exotic species in the park landscape, particularly in the north and east side. - Risk of silting of the Ribeirão Cachoeira Estreito River in the park boundary, due to incorrect conservation practices (Squatters occupied an area close to the sources of this river, practicing an intensive shifting cultivation). - There are many erosion pockets in the park vicinity. - Risk of poisoning rivers due to pesticides and fertilisers. Dead fishes have been observed in the Ribeirão Cachoira Estreito River. This problem was associated with the cotton plantation on the west side of the park. - Sugar-cane plantations surrounding the northwest area are a serious menace, leading to the spread of fires within the park. Furthermore, the sugar-cane area around the park has increased. Fire is also used for a pastureland management. - Biological plague control methods have been used in these plantations. The resulting effects to the fauna of the natural forest are unknown but believed to be serious. - Cattle ranching is the dominant activity adjacent to the park. There is a cattle sickness (aftosis fever) which was observed in the Park fauna, such as the tapir (*Tapirus terrestris*).
Construction of a railway line	- Although it is no longer used the line represents an interruption of habitats for fauna and increased erosion.
Construction of the paved road SP-613 which crosses the park (about 15 km) (See Plate 6.1) .	- Interruption of habitats for fauna. Cars have been killing animals. - Noise along the road. - Continuous risk of fire.
Construction of an small air field to serve the companies CESP and PAULIPETRO (See Plate 6.1 on the east side).	- Deforestation. - The use of this area caused a fire which destroyed about 700 ha of the park vegetation in 1991 during the dry season.
The construction of the Rosana dam (see Figure 6.4)	- About 7% of the park vegetation was deforested near the Paranapanema River. - The reservoir flooded the most significant part of the natural forest in 1986 (5.2 %), an important habitats for the black-lion tamarind.

Sources: Leite, 1981; Leite, 1991; Carvalho et al., 1989; interviews with the park manager and park staff (1991; 1992; 1994; 1995); observation of the surrounding area and it was also possible to see animals killed by vehicles (1992; 1994; 1995).

Valladares-Padua et al. (1990) suggested that government could negotiate land titles in the west side where the Reserva Grande Pontal is located, but keeping areas as corridors linking the forest fragments to the PEMD. There is a commission from IF being carried out by the PEMD manager that is studying the creation of an APA and other protected areas in the Grande Reserva do Pontal, as there is not much

natural vegetation left and much of the area is already occupied by private users. One of the measures being studied is to give permanent land titles only if owners keep 20% of natural vegetation and undertake reforestation of the gallery forest area according to forestry legislation. Another proposal is to designate some of the significant fragments, such as Tucano, as a Biological Reserve. This study is to be presented to CODESPAR, but all these actions have been painfully slow and fragments have been subject to rapid deforestation. Therefore, management of adjacent areas has further complications as the land ownership is not consolidated on the west and north side of the park.

Soil erosion is a major environmental problem in this region because of the devastating deforestation and the lack of conservation practices. Silting of the drainage system is obvious to everyone who comes to the Pontal do Paranapanema region. Fire is another anthropogenic element of the regional landscape which threatens the park forest. During the long dry season between April and September this is a serious menace to the park. There is a small buffer area (about 20 m wide) planted with grass around the park which is not enough to avoid fire propagation from the surrounding areas due to strong winds during the dry season.

The main causes of the deterioration of the natural forest, and therefore the reserves were, and are, intrinsically linked to the lack of human and financial resources for management and protection, to the lack of priority and commitment to conservation.

The PEMD requires the establishment of a buffer-zone to protect wildlife, particularly those endangered animals, by means of corridors accessing the small forest remnants around, and at the same time use socio-economic buffering. The areas around the park are very degraded, and IF and the Park could develop or guide a programme of reforestation in a buffer area within the surrounding privately owned land. It would be relevant not only for park management but for improving the lands

conservation whilst also providing some commercial alternative reforestation to the pasture land. There are nearby, particularly on the east side, some areas inhabited by landless people recently settled on official land, and this could contribute by offering some alternatives such as commercial reforestation for instance with rubber trees, which has been used in some areas in Presidente Prudente region. An important requirement to plan and monitor any kind of sustainable development in the adjacent areas is the availability of information (soil, land use, property boundaries, landownership situation, etc.). Information gathering is a tool for sound planning and management. However planning and management need investment and commitment of the government institutions both local and state.

In the view of the present manager, visitor demand should not be encouraged in this park because of its unique significance and, additionally, because there are not adequate human resources to cope with a sound and well controlled visiting system. For instance, there is a shortage and discontinuity of trained personnel to carry out interpretative and educational programmes and for protection, whilst there is lack of information and sufficient field studies to develop an adequate zoning policy or to define carrying capacity[36]. The park has been mainly receiving organised school tours and university education fieldwork training. There are no camping areas. There are two trails which can be accessed by visitors: the trail to the Devil's Hill from the top of which there is a panoramic view of the well defined park boundary; and the trail of the black-lion tamarind near the Paranapanema river. The park also has a small Arboretum with a picnic area, and a visitor centre with a small natural history museum. These activities have all been recently developed in the area, but require previous appointment with the administration staff. However, the number of visitors has been dropping since 1989. In 1989, the number of visitors registered was 6,354, and it was reduced to 4,198 in 1995 and 3,329 in 1995. This is due to shortage of

[36] Interview with the park manager (1992).

staff to support the demand. According to the manager and the visitor guide they have been refusing tours due to this problem.

6.6.3.2 - Management of the natural resources and information issues

The causalities seems to be the rule in the history of establishment and management of the parks. In the case of State Park of Morro do Diabo-PEMD the agreement among CESP-IF-FBCN provided some resources for implementation of the Park infrastructure and for the development of research in detail about one of the most endangered fauna species of the Atlantic Forest domain, as a consequence of the construction of a Hydroelectric Power Station associated with pressures of the growing environmentalism. However, there is no continuation of joint research and projects among these three agencies. Furthermore there is concern about the future of the park when the agreement finishes.

Although PEMD does not have a management plan, in 1983, a team from the IF (Guillaumon et al., 1983) proposed a series of general studies for the management of the PEMD, which was presented to WWF/IUCN. The development of detailed studies and surveys of the biophysical and cultural elements of the park were recommended, including climate, geology and geomorphology, soils, vegetation and flora, fauna, archaeology and history and also environmental education. It was believed to be necessary to initiate a detailed study of climate in order to identify possible changes in the park fauna and flora which may result from the Rosana, Taquaruçu and Primavera reservoirs. The regeneration of degraded habitats is another management requirement which was identified and, although there has been some attempt to carry it out, there has been no monitoring programme or systematic study of this kind[37].

[37] Information obtained from the park manager (1992/95) and from an ex-manager and researcher, who attempted to implement the restoration project (1995).

Vegetation and fauna management and information issues

The acquisition of knowledge about natural resources is essential for conservation management, which demands a comprehensive approach to park resources. The requirements for ecological information are well stated by Guillaumon et al. (1983) in the *Estudos para o Manejo da Reserva Estadual do Morro do Diabo* (Studies for the Management of the State Reserve of Morro do Diabo):

> *'The phytophysiognomic and phytosociological studies from the present communities will be the basic element in defining the forms of integration. The research of populations of preserved fauna and of the areas inhabited by them will lead to the type of intervention required for conservation. In order to achieve such objectives it is necessary to develop detailed research and analysis of the climate, geology and geomorphology, soil, vegetation, flora and fauna. These studies will provide a more deeply integrated view and a maximum of data that being correlated will provide the basis for re-establishing the balance.'* (1983, p.75)

However, so far the black-lion tamarin has been the only animal which has been studied in detail (see Coimbra Filho, 1976; Carvalho et al., 1989; Valladares-Padua et al., 1990; Valladares-Padua, 1993). The reproduction biology project for the tamarind re-introduction within the area no longer exists, as it was transferred to the São Paulo city Zoo owing to idiosyncrasies amongst researchers and managers involved with the management of the animal in the area, and to staffing difficulties[38]. There is no systematic monitoring programme being carried out for this animal or any other in the park. The experts in black-lion tamarind in IF (based in the central agency) are no longer working in the park (two of them left the job)[39].

The recent creation of an NGO for black-lion tamarin studies (IPE based in Piracicaba city) may be considered as an substitute for the lack of human resources in the park and central agency. The NGO could be responsible for animal studies and for monitoring within the area and region. Presently they are working on the

[38] Interview with two researchers involved with this animal research in the park, and with the park manager (1994/95).

[39] According to interview with park manager, one is nearly retiring and is no longer involved with Black-lion Tamarind studies in PEMD, and two others left the job.

identification, study and re-introduction of this animal in the forest fragments occurring in the private areas near the park. They are also monitoring this species in three areas: Rosanella/Tucano, Ponte Branca and Santa Maria estates. The IPE has a logistic base in the Pontal do Paranapanema area, in Teodoro Sampaio town, with four persons working full time, with equipment and vehicle[40]. Thus, work with this species in the park requires a strengthening of the co-operation between the two institutions, which is very important for the survival of the animal populations inhabiting the residual fragments of the Atlantic forest domain.

There is much to do concerning the fauna studies. There are many other endangered animals in this park, such as the *jaguar*. It is likely that the PEMD contains the most dense population within the Atlantic forest and there are no studies nor a monitoring programme on the species ecology[41]. Equally there is an absence of studies about the tapir, the largest mammal in South America, and about birds such as the *macuco*, which is endangered[41]. Lack of human resources to study fauna within IF and also at the universities is one of the important alleged bottlenecks and reason. CESP is giving priority to the mammals projects (jaguar and deer), in the area to be flooded in Primavera dam; monitoring of howler monkeys in areas of reintroduction after lake formation of Taquaruçu dam in private fragments; and to the programme of marking birds in the reforested areas concerning the Rosana dam[41]. Furthermore, it has been affected by cut-backs in human resources as a consequence of State government change. Even though CESP has experts on the jaguar and the howler monkey, the experience and equipment to work with them. Although CESP, IF and Universities have resource problems, a joint project with the park could help to minimise the limitation in resources.

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[40] All information about IPE was provided by interviews with two researchers from IPE (1992, 1993 and 1995).

[41] Interview with a researcher of fauna from CESP, who participated in the IF-CESP joint programme (1995).

During the joint CESP/IF/FBCN-WWF programme, many interested researchers appeared in the area willing to develop studies, but after this early stimulus, it seems the interest of studying wildlife has disappeared[42]. Moreover, the results of the many proposed works are unknown to the park, i.e., it is unknown even if they were really developed[43]. Thus, another important issue is access to information.

In terms of vegetation, the only work on phytosociology is concerned mostly with the area which was flooded (see Guillaumon et al., 1983; Baitello, 1988; Pastore and Berzaghi, 1989). This resulted in a Ph.D. work which defined trail samples for phytosociological studies in the most preserved area taken along one km trail in three ecotopes: top, slope and valley (see Schlittler, 1990). However, while the above studies from CESP-IF agreement were based on a combination of two methodologies- plot and point centered quarter, the work by Schlittler (1990) was based in point-centered quarter. Accurate comparison requires the adoption of similar methods. There are a few lists of local flora species such as the ones by Mainieri (1970), Baitello et al. (1988) and Pastore and Berzaghi (1989)- the two last ones from the programme CESP/IF and concentrated in the flooded area. Presently, a joint project involving three State Universities, IF and IBt was started to collect flora data from the flora of the State natural vegetation. Thus, there are bits and pieces of studies scattered through time and place.

Nothing has been done on detailed soil or on geomorphology studies and there is not any established monitoring programme for the fauna and flora up to present. After flooding, a few scattered and unrelated ecological studies and research projects were completed, including two Ph.D. studies, one concerned with flora and another with fauna (see Schlitter, 1990, Valladares-Padua, 1993). The interviewee park researcher and ex-manager points out:-

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[42] Interview with a researcher from CESP, who participated in the IF-CESP joint programme (1995).
[43] Interview with a researcher from CESP and with the park manager (1995).

'Although there has been some sporadic research from the universities such as UNESP, Londrina and Maringá, the PEMD is still underused as a laboratory for the universities, and lacks particularly research for management.' (1995)

Researchers from universities in general seem to be interested in sorting out the short term problems of their individual research projects. Obviously, research is important and studies should not be stopped, but point data and scattered studies in time and place do not give a good basis for management, which requires studies on a continuous and systematic basis. The park should have a research programme to guide the work of outsider researchers, suggesting standards for data collection, including consistent phytosociological data collection methods, or geo-referenced system such as UTM. It is therefore necessary to improve co-ordination with research institutions.

Furthermore a management plan has not yet been developed. Although Dreshler (1975) proposed a preliminary zoning for the park area, it is now outdated, and as mentioned by the park manager, it requires a more detailed study. The park manager[44] observed for instance, that he limited the entry capacity of the park to 50 persons per day but it was not based in any previous study. Thus planning has been based more on background information than on scientific information. Obviously informal information is important but this kind of information needs to be improved by more reliable data.

The area which was covered by the reservoir was subject to a detailed vegetation survey, including phytosociological studies and vegetation mapping. The other important project funded by CESP/FBCN-WWF was the study of the behaviour and dynamics of the black-lion tamarin. However, although proposed (see Sério et al., 1984) so far there has not been a systematic study of phytosociology with the implementation of permanent plots in the principal vegetation units of the park area, nor a monitoring study for the restoration of vegetation in degraded areas. The same

[44] Information given by the PEMD manager (1995).

can be said about fauna, after 8 years of research proposal, apart from the black-lion tamarin, no other mammal deserved any detailed study in the area. There are mainly lists of species. However, there are other endangered fauna at risk with extinction within this park mentioned in the official list (such as *onça-pintada*). Thus research studies are scarce and there is a lack of a monitoring programme on the ground.

A triennial pilot plan for study and management of the black-lion tamarin in the PEMD and adjacent forest fragments was proposed by Valladares-Padua et al. (1990). The plan mentioned a pilot project in park regeneration which was starting to be implemented. However, this project was put aside after the manager responsible for the elaboration of the project moved to a different area (presently managing an Experimental Station). The co-ordinator of the plan is no longer involved with the PEMD, the counterpart of IF is no longer working there. According to the ex-manager responsible by the project, an experiment was established in one of the degraded parts of the park but it lacked continuity and no monitoring was done. At the same time, the importance of continuity is emphasized in the preliminary management plan for the black-lion tamarin in item 5.4. Thus continuity is a further issue for the management of park.

A critical issue for ecological studies and data collection is the shortage of expertise in the central agency/IF and within parks to cope with the biodiversity of the many parks and reserves of the State. Furthermore, it seems that Universities usually produce research work in the parks when related to post graduate studies, and this does not lead to the establishment of long term studies. Co-operation with Universities is crucial for the required studies and for monitoring. Although Universities are also affected by resource problems, joint efforts can help to improve ecological data availability and studies to serve to park management. The alleged difficulties for Universities to work in parks are lack of adequate infrastructure, personnel and access to the areas. However, in some ways the parks are improving,

for instance the PEMD presently has better conditions than ever in the past to receive researchers (adequate accommodation, some available vehicles, etc.) so they do not need to invest their own resources for park researches. This could be a major contribution to science and lead to more sound management. However, it does require strength of co-operation and a more systematic work in the areas, i.e. not only in order to produce post-graduate theses. In general, a Ph.D. study in ecology is based on a short-term data collection and ecodynamic studies require a long-term research.

Thus, it is necessary to establish a research programme and give it continuity on a long-term basis. An example is Luquillo in Costa Rica, with 100 years of data collection of biophysical parameters. It is well known that there are not many trained personnel available to undertake studies in fauna and ecology in Brazilian Universities, but joint efforts could minimise the resource shortages of both sets of organisations. Additionally, universities can have parks as their experimental areas and for field teaching. However, the manager of PEMD points out that universities also have problems of resources shortage and time constraints as parks do. On the other hand a researcher of CESP-IF programme (1994) argues:-

> *'There is a lack of tradition in developing both ecological and human research in the parks and protected areas related to management needs.'* (1994)

It seems that Universities have some well-established areas to study and to serve as a laboratory for students teaching, where there is a degree of infrastructure. Obviously, this problem was related to lack of adequate infrastructure in most State Parks, but there have been some improvements.

Positive actions like opening up areas of the park for visiting with new trails and camping areas, are not undertaken, owing to insufficient knowledge of the ecology. Furthermore it requires monitoring of use, and visitors impact which places yet further demands on human resources for the study and surveys.

Furthermore, a programme of research directed towards short and middle-term solutions of management problems is necessary. As one of the interviewees considers[45]:

> *'Most of the studies done in the park are descriptive and not applied to the immediate needs of management. For example it is required to monitor the fauna mortality on the road crossing the park which has been considerably high.'* (1995)

This kind of example gives a picture of the lack of a research programme guiding the priorities for study within the area. This requires trained personnel to co-ordinate and interpret research developed in the area for management needs. Lack of suitable personnel and training, associated with problems in continuity of administration, is a further difficulty in this area.

Information is centralised within IF in São Paulo city. The spatial information and data such as maps, aerial photographs and satellite images are stored in paper format archives in IF. Furthermore it was only recently that the PEMD acquired on site a collection of basic topographic maps at the 1:50,000 scale and xerox copies for the 1:10,000 scale, as a personal initiative of the present manager. The processing of data is usually done in the central agency (maps, research analysis, aerial photography and image interpretation, etc.). There is no equipment for fauna observation and data collection in the area, apart from a pair of binnoculars in very poor condition[46]. There are no materials for spatial data gathering and processing such as stereoscopic equipment, theodolite and levelling equipment, precise metric tapes and rulers, compasses, GPS equipment, polyester paper, drawing pens, translucid table, or tracking radio. Equipment such as a GPS is not available even in the central agency. There is not a PC in the park and it was only recently that DRPE acquired a few 286 PCs and one 386 PC in the central agency and started to adopt DBase software. The

[45] Researcher who worked in the CESP-IF research programme (1995).
[46] See the park document which identifies the current situation of the material and human resources available in the park (Vilela, 1992).

staff in the park have no experience with computers, even the high-level personnel, such as the park manager, who does not have any kind of experience, even with word processors. In addition, although the manager already knew the term GIS, he did not have a clear idea about what GIS was or what it could do. He said he has not had any interest in the subject so far. When the author explained what such a system could do, the manager pointed out that, given the resource constraints, it was too advanced for the park to have it on site. He mentioned that the park does not even have a telephone line. A researcher (working on the CESP-IF joint projects) expressed his concern about the introduction of such a tool in the park:

> *'The human and financial resources of the state are too unstable. This system may be feasible at the university. However, do not think of reproducing something similar to that existing in the developed countries. It is not feasible.'* (1994)

There are no air conditioners essential to keep computers in good working condition, particularly in high-temperatures and humid rooms. However, the manager expressed his interest in having at least a PC with a wordprocessor, and perhaps in getting some more sophisticated software such as GIS in the future.

A key informant on the park staff (a guard with university level education) mentioned that GIS was not a strange term for him but he could not say what it was and how it could be used for park management. The researchers' key informants (workers on the CESP-IF joint projects) were aware that GIS is a kind of complex remote sensing and mapping based system, and like the manager they were sceptical of introducing it in the park context at present due to the resource constraints.

The analysis of the components of data quality (time, completeness, lineage, accessibility, etc.) is an important issue on the information system. Table 6.6 indicates the kind of spatial data available for the park and their characteristics.

Table 6.6 - Spatial Information available for the PEMD, most of them found in the central agency.

Type (paper)	Year	Scale	Source Agency	Local-originals
Map				
Topographic map	1974/75	1:50,000[1]	IBGE	IF[5]
Topographic map	1984/85	1:10,000[2]	IGC-Terrrafoto	IF[5]
Vegetation map	1970	1:25,000[3]	IF (photos/ 1962)	IF[5]
Soil map	____	1:200,000	Hidroservice/CESP[4]	CESP
Geomorphology map	____	1:200,000	Hidroservice/CESP	CESP
Land Suitability map	____	1:200,000	Hidroservice/CESP	CESP
Geology map	1991	1:500,000	UNESP-PP	UNESP-PP
Aerial photograph				
	1955[6]	1:20,000	IGG (VASP)	IF
	1962	1:25,000	IGG	IF
	1978	1:20,000	CESP/TERRAFOTO	CESP
Satellite Image				
Color composition-TM	1991	1:50,000	INPE	IF
Black and White-TM Band 3	1987	1:100,000	INPE	IF

[1] Features such as rivers and contour lines do not match between the two sheets (SF-22-Y-B-I-3, published in 1974 and SF-22-Y-B-IV-1, published in 1975). This is a very gross error, caused by inadequate quality control.

[2] These maps were produced from aerial photographs of CESP property from 1978 (scale 1: 20,000).

[3] This map was produced by using aerial photographs from 1962 at scale 1: 25,000. UTM projection was adopted. However, because of the method used to produce the base map in such scale (see Campos and Heinsdijk, 1970), the position accuracy probably does not match the cartographic standards. Nevertheless, the thematic information was done by IF team (Campos and Heinsdijk, 1970) which used samples in a regular/systematic grid of 400 m (0.4 ha.). It needs to be updated; during 1970s the park was affected by massive burning and also in the 1990s.

[4] The map base adopted was derived from a topographic map 1:50,000. These Thematic products were generated by the private CIA Hidroservice for CESP project in early 1980s. However, the scale is too broad for the park management needs.

[5] Copies of these maps can be found in the park office archive. The current park manager was responsible for the acquisition of copies of maps on spot. He has also been gathering available publications about PEMD (in papers and newspapers). There is not a staff member responsible for such a job to organise information.

[6] These aerial photographs are kept in the archive of IF. It was possible to observe that some of them are in process of deterioration. Old aerial photographs are very important for restoration studies.

The topographic and vegetation maps are outdated. There is no consistency in the scales, some of the map scales are too small such as, soil, geology and geomorphology maps. Although Project OLHO VERDE produced updated mapping of natural vegetation of the State (in paper and digital format), satellite image (Landsat TM colour composition-1:50,000) was used and the classes are too broad (*forest, cleared land, shrub savanna, etc.*). One important source of information for the park management is a land use map of the adjacent areas to the park, as well as

cadastral maps of landowners. However, such spatial information is not available at all in any organisation.

Fire management and studies

One of the major problems of this park is fire, particularly during the dry season (around 6 months). The park is bounded by pastureland and few areas of agriculture (sugar-cane), with burning practices, and is cut by the main access road in the region, all of which constitute permanent risks to the park. Therefore the park requires to establish a system of fire registering at a more local scale, and to make its own study of the occurrence pattern on a temporal basis to give support for fire management and regeneration programmes.

An important information component is the size and kind of habitat burned and the monitoring of regeneration. This could be mapped by a Small Format Camera, which is a low-cost alternative for small areas, particularly where there is already a topographic map at a large scale, such as the example of the PEMD. It is very important for the fire management, to know the causes, date and location (which vegetation and resources, how much was degraded, etc.) of fire, which may show some patterns of occurrence (do they come from the same direction? which is the direction of winds?). GIS can be used to extract the variables of environmental and human factors for studying fire behaviour and occurrence probabilities to support fire management. These factors involve data on temperature, precipitation, vegetation, slopes, past-burned areas, roads and structures. However, there is not any mapped information or spatial monitoring of the burned areas in the PEMD. Additionally, spatial information on roads, trails, structure and vegetation are all outdated. The park vegetation map was produced with aerial photographs from 1962 (Campos and Heinsdijk, 1970), yet from this time till the present, massive fire outbreaks and degradation have occurred.

Water Management

Water monitoring and studies are very important issues for PEMD management. This park is a fragment of natural vegetation surrounded by pastureland and agriculture. Additionally, more than half of the park boundary is formed by two rivers. The Paranapanema River is one of the three largest rivers which divides a long extension of two States, São Paulo and Paraná. A programme for water management is therefore necessary and, detailed data on water quality are very much required on a continuous basis.

6.7 - Discussion

- **Assessment of the park context**

The establishment and implementation of parks and protected areas (Unidades de Conservação) in Brazil have been threatened by lack of resources and inadequate priority in government programmes; by colonisation and economic development pressures; and by the caprices of the political-administrative processes.

Leite's study shows how the lack of government commitment to conservation coupled with a lack of political-administrative continuity, badly affects the allocation of resources for park implementation and management.

Although the environmentalist lobby has become increasingly strong in the last decades, associated with the slow consolidation of the democratic process, the circumstances in which the PEMD has been implemented have depended much upon incidental resources. Furthermore, although the situation of the park apparently evolved, yet it relies on unstable sources of financial resources (the CESP agreement is nearly finished and government allocations provides a too meagre budget) and on inadequate human resources (not enough personnel for research, lack of regular training, function deviation, instability of managers and a high-level technician in the area, lack of co-ordination for a research programme establishment and monitoring of

natural resources) for long-term operation, maintenance, and particularly for research studies and monitoring. As IUCN (1986) and Tchnell et al. (1987) found for protected areas in the tropics, the lack of sufficient trained human resources associated to the lack of more effective co-operation with research centres is one of the most critical management problem in this park. Additionally, at present efforts and priorities for allocation of available financial resources of government and international agencies are directed towards to the coastal parks land regularisation and implementation of basic infrastructure (such as vehicle acquisition). Therefore these issues will be discussed bellow.

Human resources

The introduction of a GIS technology requires specialised personnel, training and re-training possibilities. The lack of regular training, even for basic management tasks, function deviation, lack of an adequate career plan for middle-level technicians, low salaries and continuing uncertainty over the position of high-level technical positions are further difficulties for management and for the establishment of one form of information technology innovation in this park. Thus, lack of adequate personnel and of better salary and career policies jeopardises any attempt to develop a more sound and scientific-based management. The salary policy is not encouraging for either managers, researchers or other staff members of IF. This is aggrieved by the lack of more effective and continuing co-operation with research centres. Therefore, as IUCN (1986), Machlis and Neumann (1987) and Amend and Amend (1992) found, shortage of adequate human resources is still a major problem for management of parks in the context of the tropical developing countries.

Funding issues

The uncertain and highly political nature of funding is one of the serious hindrances for management. Apart from the government budget, which is too meagre for maintenance and operation, and has been subject to heavy cut-backs, and the current CESP funds, which are nearly finishing, there are no other sources of financial resources for the PEMD. Centralisation and bureaucracy make it more difficult to access government and international resources. Additionally, any international funds recently received have been prioritised for the creation of infrastructure in parks of the coastal areas, which were nearly abandoned. Therefore, as Redclift (1987) and Curtis (1993) note, the inadequate government funds for long-term operation and management of protected areas is a critical problem in developing countries.

Data issues

Data availability is another critical issue. Nevertheless, there is some relevant spatial information even though part of them is too small scale, others such as vegetation and land use are outdated. There is a lack of ecological and environmental knowledge. There is neither a systematic ecological monitoring system nor a research programme, even for the most endangered fauna of the area. Without adequate ecological information and monitoring of the dynamics of the environment, it is difficult to see how a sound management system can evolve. Such a system is important in order to identify trends and to define or change management strategies. The difficulties experienced in acquiring ecological information is due to a shortage of human resources and to a lack of multidisciplinarity in the park. Thus, it is necessary to strengthen co-operation with universities and other research centres in order to overcome this problem. An effective joint effort can serve to minimise human resource difficulties of both the park and universities.

Infrastructure and equipment

PEMD has a reasonable infrastructure. There are lodging facilities for researchers even though there is not a laboratory or research equipment in the area. The park has a reasonable system of trails for operation, however, it does not have a good mean of communication, such as telephone booths. The communication system is too old, there is a radio system which has frequently been out of order. Furthermore, the external contacts have to be made via central agency in São Paulo City (about 700 km), even if one is very close to the area. This is a greater difficulty for researchers and guided visitors requiring to access the area (visiting must be scheduled in advance). Additionally, this area is subject to fire hazards during the long dry seasons. A communication system is essential for an effective fire combat and management. The lack of regular maintenance of basic equipment such as radio and vehicles is therefore one of the main problems to be worried about.

Plan and Programmes

The lack of a management plan and better established management programmes and studies (e.g., habitat restoration, edge effect, etc.) adds further to the problem for a sound and scientific-based management of the park, which also lacks clear guidance to develop and evaluate management strategies. This leads to a very personal and informal kind of management. Furthermore, continuity of research projects has been jeopardised by a shortage of human resources and lack of more effective co-operation with research agencies. Despite its disadvantages, the informal and personal style of management by the park managers can be seen as the best way to deal with and adapt to the limited resources, the difficulties of centralised bureaucratic control, and the absence of an agreed management system that promotes on-going evaluation of and feedback on management actions.

- **Evaluation of the alternatives for introducing GIS**

In a discussion about the current use of GIS, Gugan and Gliddon (1991) note that systems are difficult to use, having a long learning curve, and therefore cannot be used effectively by occasional users. Thus education, training and a stable human resources team are essential requirements for successful running and use of such technology. Adequate human resources and the lack of a programme for training are limiting factors for the management of the park. Additionally, park personnel do not have experience with computers at all.

In the case of PEMD, which is the furthest and the most isolated protected area from the central agency (about 10 hours by road), the creation of a spatial database could be started by the UNESP located in Presidente Prudente City (about two hours by road from the park). The local branch of the UNESP- on the Campus of Presidente Prudente - has been developing many studies and projects in the Pontal region, from socio-economic studies to mapping of the area, including experiments with SFC. It has also been providing support for the Procurator's Office in land reform studies. Recently the Department of Cartography proposed the creation of the Centre of Mapping (*Centro de Mapeamento-CEMAP*) in this University, which includes a programme for the establishment of a GIS for the Pontal do Paranapanema region[47]. A spatial database for the PEMD could be established by using the software and hardware infrastructure available in this University such as AutoCAD and Microstation/MGE packages, DBase software, PCs and workstations, digitizing tables and plotters. This database could be accessed by the park manager and researchers. CEMAP aims that both University researchers and external users utilise the system, by providing data and defining their needs and also by directly using this tool. It could

[47] The objectives of the Programme *SIG- Pontal* involve integration of available spatial information within the Pontal region, creation of a database for regional planning, and keeping it updated. It also intends to provide training in GIS and to create a centre to co-ordinate and disseminate information to meet the needs of potential users from research, teaching and other organisations. Such an information system programme could provide an integrated perspective to create a regional database of the Pontal region.

help to train park personnel and, at the same time establish the park database that could be transferred to the central agency in the future, and to the park office itself when facilities become available. In the short-term and middle-term spatial data for the park could be transformed into a digital format, either in the AutoCAD or Microstation/MGE packages. AutoCAD should be preferred for training the park manager as it is already available in the central agency. This could be regarded as a more centralised approach for developing the use of GIS for PEMD.

Another alternative and/or complementary approach is to start the use of information technology in the park itself with simple PC hardware and very simple, easy to use non-GIS software such as DBase. This could be useful to organise the park personnel data on site, which require to be updated by the central agency on a 6 month basis. Such a system could also be used to create a small database containing information on owners of properties adjacent to the park, for instance for fire record information. This could be seen as more decentralised approach and is outlined in Table 6.7. This approach could give park staff more direct learning and experience and provide them with some basic skills to deal with information technology. It is worth emphasising that the decentralised and centralised approaches are complementary and can therefore be combined. The Central Agency and/or University can make the digital acquisition of the available spatial data for the park as they have already software for spatial data handling, and in the short-term to middle-term, the park could start working locally with simple non-GIS software as suggested in the Table 6.7.

Table 6.7 - Alternative proposal for automation and GIS introduction in the PEMD using a decentralised and phased approach.

Hardware	**Non-GIS software**	**GIS software and peripherals**
PC (286 or 386 + printer)	Short-term to middle-term (e.g., DBase and/or Lotus[1])	Long-term (e.g., IDRISI[2] and a plotter) - over 5 years.

[1] Both are available in the central agency office and in the UNESP at Presidente Prudente.
[2] This software package is a raster based GIS. It can import-export DXF and convert from vector to raster.

These alternatives attempt to take into consideration all the actual available park resources and difficulties. Basically the fundamental principles are smallness and careful use of the meagre resources by adopting a more phased approach for automation by using available local infrastructure and expertise. International funding may be available, and it can help at the start but it is not embedded in the organisation's financial structure to maintain the system in operation. Therefore, a realistic approach for automation in the park could be to start with a simple non-spatial system as suggested in Table 6.7. At the same time, the park manager could use the resources of the University (Unesp), which is close to the area and is willing to provide training to familiarise managers with GIS concepts and with systems designed for handling spatial data. Therefore, this phased and integrated approach with the local University has the advantage of saving resources and providing training for park staff in the concepts and applications of geo-information technology. This would constitute a sound use of available resources and would only require the strengthening of co-operation at inter-agency and intra-agency levels.

Furthermore, one of the important steps for improving the information system is to establish more effective co-operation for data collection and provision by encouraging programmes of research on a continuous basis, linked to management needs. The establishment of a management plan and its continuous evaluation and updating are what is required most for successful management of the park, and therefore for the effective use of information system technology.

One of the potential areas for GIS application in PEMD is in wildlife management. For instance, a GIS could be used to produce information on habitat distribution in the case of the black-lion tamarin, which is the species studied most in the park. Such a GIS pilot project applied to fauna studies, could help researchers and park managers to gain knowledge of the kind of problems and of potentialities which use of a GIS could bring.

CHAPTER 7

Case Study II: State Park of Campos do Jordão

7.1- Introduction

This chapter evaluates the institutional and organisational context of a state park. The analysis is based upon the example of the past and contemporary situation experienced by the State Park of Campos do Jordão. The discussion considers the principal constraints of introducing GIS technology into the contemporary situation of the park development. Human resources and funding issues are shown to be important factors which can affect the efficacy of GIS technology as a state park management tool. An evaluation of data availability issues is considered as data input is an important element of an information system approach. Finally, a discussion of the possible alternatives for information system technological support is undertaken.

7.2- Description of the Area

7.2.1- Location and socio-economic characteristics

The PECJ is located in the north of the municipality of Campos do Jordão, to the north-east of the State. The park area is 8341.86 ha., which represents one third of the municipal territory. PECJ is located within the State APA of Campos do Jordão, and the Federal APA of the Serra do Mar (Figure 7.1).

The most important economic activity of the municipality of Campos do Jordão is tourism. The area is located on the Rio-São Paulo axis, the most industrialised and densely populated area of Brazil. These characteristics, and the improved access to the area following the construction of state road Taubaté-Campos do Jordão (late 1970s), greatly influenced the growth of tourism in the area, and therefore the visitor demand to the park increased.

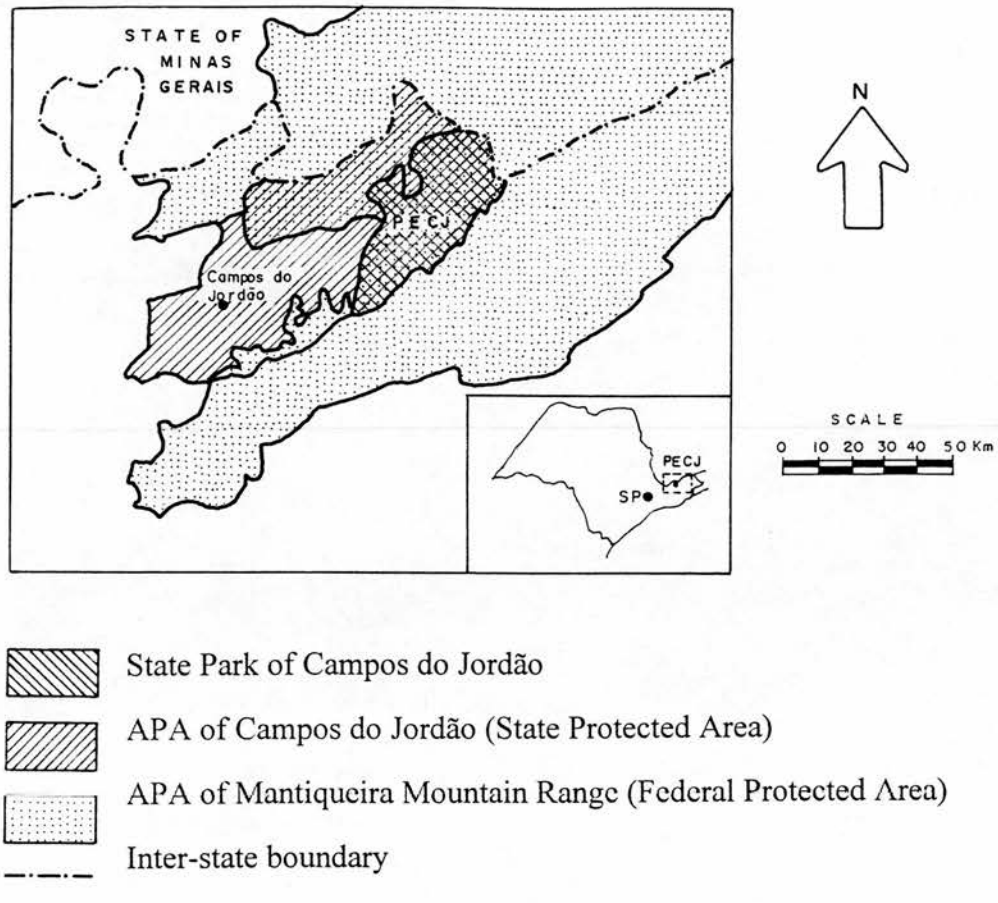

Figure 7.1- Map of PECJ location.

The visitors are mainly from São Paulo city, about three hours from the area. PECJ has a high visitor demand which grew strongly during the 1980s. However since the late 1980s, the number of visitors has been decreasing (Figure 7.2) - a feature which seems possibly related to the middle class economic crisis, even though it has still been receiving higher numbers of visitors in recent years than the early 1980s. PECJ can receive more than 2,000 visitors per day, particularly in July[1]. PECJ is located in the only highly visited winter tourist area of the state (Campos de Jordão municipality), and therefore July is the busiest month for visiting. Although the park charges entrance fees, this income does not remain in the park. The main source of finance is the government budget.

The involvement of local population with the park seem to be mainly through school pupils and teachers. As an example, there is a project for environmental education in the Campos do Jordão schools which involves visiting an area of degraded araucaria forest located in the town (*Morro do Elefante* - Elephant Hill) and also visiting the PECJ. Questionnaires are supplied to students in the courses of classes in science and social studies before and after visiting the area. However, according to the park manager lecturers complained of lack of support from the school heads. Also local schools organise visits to the park during important events, such as "Environment Week" and "Children's Week". Although, the park has been receiving a high number of visitors, the growth of public awareness and involvement with the park will depend very much on the success of such environmental education programmes organised by school and/or park staff.

7.2.2- Landscape characteristics

The PECJ is located in the escarpment of the Serra da Mantiqueira, part of the old massif of Atlantic Brazil (Plate 7.1). The area possesses a good drainage system of mountainous streams and waterfalls, which make it very attractive. Table 7.1 summarises

[1] This information was obtained from the park records of visiting frequency.

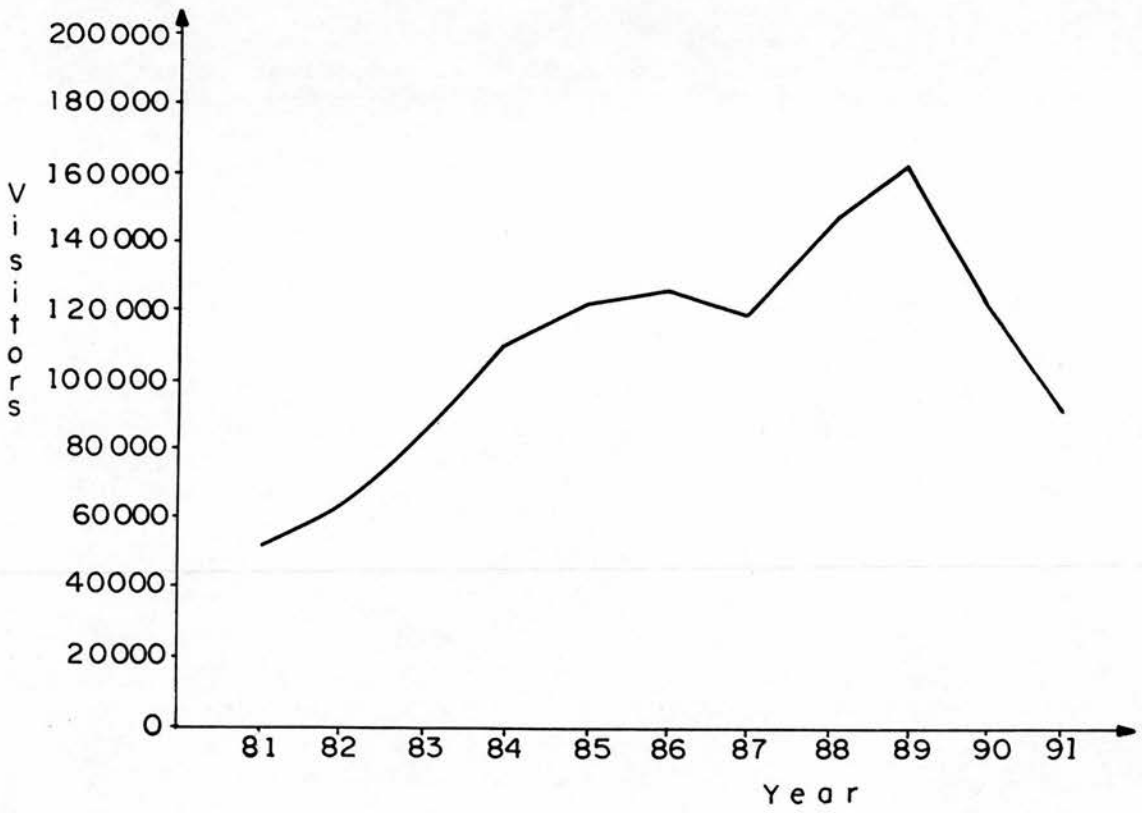

Figure 7.2- Total of visitors per year from 1981 to 1991

Source: Seção do Parque Estadual de Campos do Jordão (1991)[2]

[2] The data from 1991 was obtained from records of park visiting (*"Movimento de visitantes"*) (1992).

the general characteristics of the park landscape. The area presents a great biological and topographic diversity, adding to its tourist attractiveness and scientific importance.

The landscape of the park also contains a proportion of degraded vegetation as a consequence of past human activities (agriculture, ranching, etc.), and of the state planted forest programme in the area. The park has been subject to erosion and landslides problems, because of human activities (particularly related to roads and reforested areas).

Until the 1970s, there used to be agricultural fields and subsistence livestock activities, partially for the experimental studies of the Agronomic Institute (IA), but also for subsistence of local residents, who worked in the park. These activities have since been eliminated from the area. The planted forest represents a major part of the park landscape, occupying almost one third of the park land[3]. The management plan (Seibert et al., 1975) established that selective felling should be carried out, and the area should be left to regenerate.

7.3- The creation of the PECJ

This was the first park created in the State. In some ways it was the result of efforts of local conservationists, influenced by the national park movement in the USA and Europe. An embryo of strong ecological consciousness can be identified in the actions taken by the local conservationists, who produced a report about the critical situation of the forest coverage in the area (Ferraz, 1941). Logging, fire and ranching were identified as the three principal causes of the rapid destruction of the remnants of *Araucaria* forest in the State.

[3] The planted forest area is identified in the map of vegetation published in the *"Atlas do Plano de Manejo do Parque Estadual de Campos do Jordão"* (Atlas of the Management Plan of PECJ) (Seibert et al., 1975)

Plate 7.1- General view of the landscape of the PECJ.

Table 7.1- Biophysical characteristics of the PECJ.

Biophysical elements	**Description**
Topography	Altitude variation is between 1030m and 2007 m. The slope varies from 30 to 50%.
Vegetation	There are three zones (Seibert et al., 1975) (See Plate 7.1, in previous page): -*Araucaria* forest associated with *Podocarpus*; -Subtropical humid (Broad-leaved) forest of the Atlantic escarpment; -Southern grassland of Brazil (*'Campos de altitude'*). There are also areas with exotic vegetation such as the planted forest (See Figure 7.3).
Soil	Soils are composed of cambisols, podzols and lithosols. The lithosols occur generally over the higher altitudes of the park, being associated with the grassland vegetation (*'campos de altitude'*) (Oliveira et al., 1975).
Climate	In the Köppen classification is Cfb, i.e., altitude subtropical and humid. The annual rainfall is between 1500 mm to 2000 mm.
Fauna	The number of bird species represents an estimated 30% of the birds of the State (Barbosa, 1988).

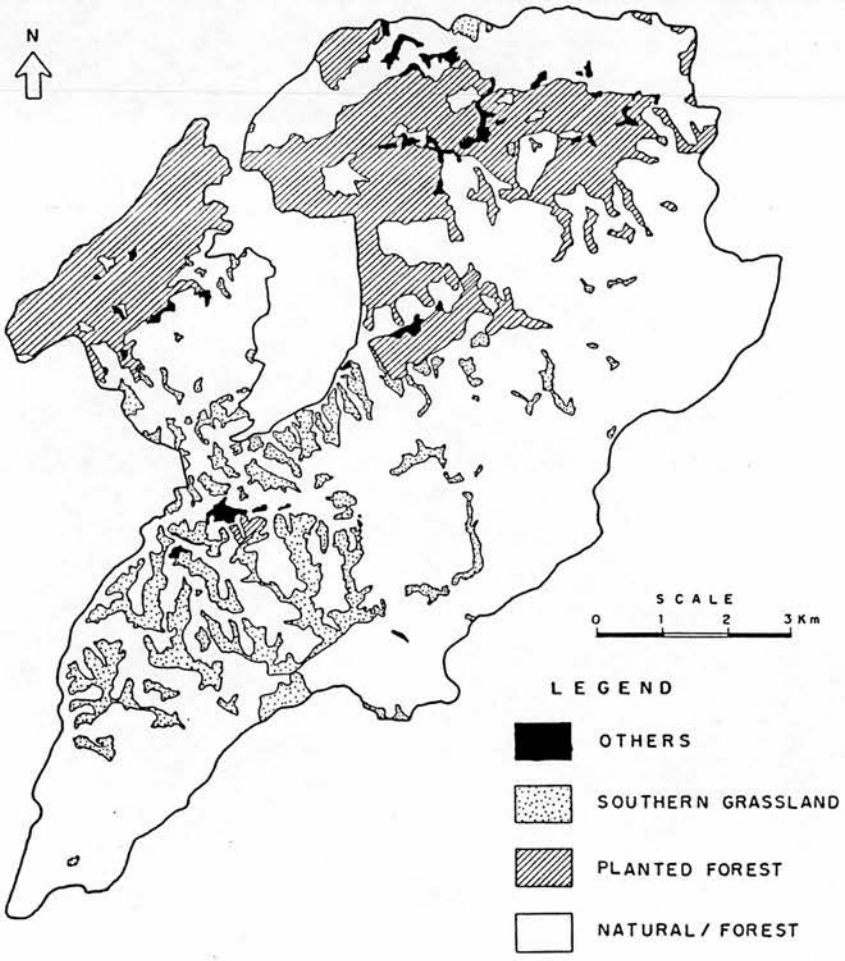

Figure 7.3 - Vegetation map of the park.

Source: Adapted from Seibert et al., 1975.

Concern over this serious picture of forest destruction led local conservationists to request the Secretary of Agriculture to take urgent measures to defend and protect the local flora and fauna *"....tremendously threatened as demonstrated in the technical report, which was presented at my request"* (Ferraz, 1941, p. 40). The conservationists emphasised the need to organise experimental stations, and to create reserves, as essential measures *"...in the country, and in particular in Campos do Jordão to save a national asset"* (Ferraz, 1941, pp. 49). In 1941 the decree which created the Park was passed (n. 11.908, 27/03/41).

At present the area of the park belongs to the state government, but the process of land consolidation took about 24 years (Seibert et al., 1975). Nevertheless, the further enlargement of the boundary, proposed in the management plan (see Seibert et al., 1975), has not yet been carried out[4]. The reduction and extinction of parks, both state and national has been done rapidly, but the reverse process seldom occurs due to the development projects and colonisation- such as the case of the Pontal Reserves in São Paulo (Leite, 1981) or of the National Park Paulo Afonso (Quintão, 1983).

At its formation, many of the park staff were local inhabitants. Many of these people were rural workers (*colonos*) dependent on farm life. By 1975, there were 573 people, including staff and their families, living inside the current park boundaries. Today there are even third generations working in the park. The park provides houses for the staff, until they retire (Plate 7.2). There is a primary school and chapel within the park boundaries.

The creation of the park was an important step for the park movement in the state in general and in safeguarding *Araucaria* forest in particular. However, the absence of a management plan until the 1970s, and of a research programme directed towards conservation objectives, coupled with a lack of government commitment to conservation management, hampered the early development of the park. Only the planted forest project

[4] Information provided by the park manager (1992).

Plate 7.2- Residential area in the park (risk of fire).

appeared to gain, with investment in staff. The growing environmental awareness and the new directions established by the park congress in 1970 led to the formulation of the management plan for the PECJ. Despite the increase in environmental interest, this plan has never been revised and proposed ecological studies should be deepened and continued.

7.4 - The impacts of the reforestation programme

A State Government Forestry Policy was implemented in the late 1950s (Seibert et al., 1975). This policy involved setting up a programme of planted forest in order to develop industrial forestry based on pine within the State (IF, 1973). The project involved the plantation of exotic pine trees within a government network of experimental stations, including the State Park of Campos do Jordão, and started in 1957. The project was based mainly on *Pinus elliottii* and *Pinus taeda*. The park was used as an experimental station without considering the real objectives of the park. Only in the mid 1970s, did this issue emerge, along with the proposal for the first park management plan, which recommended the regeneration of the planted area.

According to Seibert et al. (1975) the planted forest programme was carried out in the areas located to the north of the park. By 1969, about 2618 ha. had already been planted with pine trees, covering about 1/3rd of the park area (see Plate 7.3 and Figure 7.3). The park was created to protect and conserve the natural vegetation particularly the Brazilian pine (*Araucaria angustifolia*) forest which was being threatened by logging. A more acceptable management policy would therefore concentrate on regenerating the area instead of reforestation with exotics. According to the manager of park:-

> *'The alleged reasons for having carried out reforestation within the park was that the Forestry Service did not have Experimental Stations with the climate characteristics of the park, and therefore, this area was used to test the species typical of temperate climates. At that time there was not a well defined legislation for parks, nor a management plan, and in fact there was no real government concern with this category of management'* (1992).

Plate 7.3- Area of exotic planted forest in the PECJ.

The side effect was that personnel were specially contracted for this programme of planted forest within the park area:-

> *'Now, there are 36 labourers working in the planted forest programme, contracted and paid by the normal budget of the Secretary'* (Serviço Florestal do Estado de São Paulo, 1960, p. 33)

It was found that 84% of the staff who are still working were contracted during the period of 1958 and 1966[5]. This is the direct result of the planted forest programme. The government invested in human resources for the sake of the forest planting programme, rather than for park conservation. In fact these actions suggest that there was no real commitment to conservation objectives. The manager stresses, (confirmed by a researcher, who participated in the elaboration of the park management plan):-

> *'No doubt, the park got an improvement in the infrastructure with the planted forest programme. Labour and equipment were provided in order that the programme should succeed.'* (1992)

It is recognised that the planted forest programme brought some benefits to the area. Apart from increasing employment, buildings were constructed for the park administration and accommodation for the researchers. The planted forest also provided material for constructing the more recent buildings for visitors (reception and museum), trails, bridges, and for maintenance. However, the park received improvements because areas with planted forest such as PECJ were the main priority for investment in the Forestry Service (*Serviço Florestal*) rather than native forest, which were virtually abandoned as in the case of PEMD. The manager notes:-

> *'In 1980 there was an agreement with the Japanese International Co-operation Agency (JICA). In 1981 the Project of Forestry Mechanisation in PECJ was started, funded by JICA, which ended in March of 1986. This agreement had the objective of testing a methodology to remove logging products in mountainous areas without causing soil degradation. The benefits were a donation of equipment and machines for planted forestry, road maintenance, for construction of bridges and the training of the staff to use*

[5] Calculated from data collected by Robim (1992) (a park report produced for the central agency).

the equipment. However, this project was only developed in the park because there was a planted forest, i.e., an area to be explored which was similar to that of a Japanese landscape (very steep relief) (.....) Furthermore, in my opinion a project in the park should be started to monitor the restoration of these areas. (.....) It is necessary to develop projects for the sake of the park conservation objectives'. (1992)

Therefore, it can be concluded that improvements were incidental and not the result of a well defined policy and programme for conservation management of protected native vegetation. Thus, the park gained some benefits from more economic project and interest concerned with paper industry.

7.5- The current situation of the human and financial resources

The management plan of PECJ was drawn up in 1975, about 35 years after the creation of the park. It was one of the first management plans in the state parks (Seibert et al., 1975), together with the State Park of Ilha do Cardoso and Cantareira (Negreiros et al., 1974a; 1974b). The growing concern over environmental degradation at an international level revived and strongly influenced the Brazilian park conservation movement in the mid 1970s. The Second World Conference on National Parks, held in 1970, and the Stockholm Conference played an key role in the conservation debate in the early 1970s. The concern with the sound management of parks appears in the introduction to the management plan (Seibert et al., 1975):-

'Because of the growing urbanisation and industrialisation of São Paulo, associated with the elaboration of regional development plans without concern for the environment, actually being given lower importance, the integrity of these protected area under government responsibility is seriously threatened.
(.....)
The planning for these areas cannot be postponed. They should be elaborated to integrate them with the development of the region concerned.
The planning of a park should follow the principles contained in the Second World Conference of National Parks.
(.....)
As elaboration of such a plan is a pioneer activity in our organisation, the IF asked for technical assistance of organisations specialised in such disciplines,

for areas where the pressures are critical, and in order to train technical staff to transfer this technology to other parks and reserves'. (1975)

However, this plan was never updated, and only a few scattered ecological studies have been completed. There have been very few publications concerned, in particular, with fauna studies in the park since the publication of the management plan. Furthermore, at present the park is lacking an adequate and skilled team as will be discussed.

The management plan of the park was elaborated by IF staff and other Brazilian agencies such as IBt under the supervision of the staff involved with landscape management and vegetation mapping from Munich University (Seibert et al., 1975). The plan proposed the implementation of a new and improved administration structure based on three main activities: interpretation, management, and preservation. It was suggested that the human resources should be improved for the successful implementation of the plan. Thus it was proposed to introduce more specialised technicians in the teams responsible for the performance of the three activities. It was proposed that, for each of these, a high level technician should be responsible. The management plan contained the following proposal:-

'For the activity of preservation, which will be administered by a high level technician (university background), a guard section was created. The section of maintenance was improved.
(.....)
The activity of interpretation will be carried out by a high level technician, three middle level technicians, and seven auxiliary technicians.
(.....)
The management activity will be led by a high level technician, having one auxiliary for an agricultural engineer' (1975, p.125)

However, at present all these activities come under the responsibility of the park director, who is in the end, the only well-qualified technical staff member working in the park. The manager is also performing the middle-level technician functions, and having to adapt guard and park labourers to develop more specialised functions at middle-level. The

manager has also to cope with research tasks[6], as the career improvement of such personnel depends upon research publications (career plan). This situation, with an accumulation of many different responsibilities and functions, makes the process of park management extremely difficult. The manager also supervises the trainees who come to the park; for example, there are presently two students involved in the environmental education project of "*Trilha da Cachoeira*", which was proposed by the manager and was funded by WWF[7]. The manager emphasises this difficulty:-

> *'The park is lacking middle level technicians to give support to the managerial work. The manager has to do everything, from co-ordinating the different activities, including interpretation and the planted forest, to developing research in the area'.* (1992)

The plan emphasised the importance of having adequate personnel to perform the tasks required in research, interpretation, education and conservation. What has happened in practice is that the park has a huge quantity of lower level staff (unskilled people) mostly contracted as labourers (see park report by Robim, 1992). Because of the forestry management tradition of IF, noted in Chapter 6, the staff organisation structure of parks does not have posts such as interpreters and natural resources planners, which would be better suited to park management needs. Guards have been adapted for park needs in such positions as research assistants, and for working as park guides for visitors. The educational background of the members of staff is presented in Table 7.2.

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[6] See publications by Robim (manager) which vary from studies of park trails (Andrade, Zanchetta and Robim, 1992) to studies concerned with flora of the park (Robim et al., 1990). The manager responsible for the parks should be a person contracted as a PqC-researcher, but this does not mean that they necessarily have a post- graduation course. The basic qualification is a university level training. The background of the PECJ manager is in biology. The manager does not have any specific training in park management.

[7] Information provided by the park manager and the trainees (the project was divided in two phases as they could only work in the vacation time). This researcher followed their work in the office and in the field.

Table 7.2 - Qualification of the park staff

Level	Number	%
University	1	1.0
High School	3	3.0
Primary School*	77	78.5
Illiterate (no school)[8]	17	17.5
Total	98	100.0

Source: this table was organised from data collected by Robim (1992) (park manager)
* Until early 1970s, called primary school i.e. the 4 first years of basic education.

From the three staff who have high school qualifications, one is at the University, but holds the position of guard. The park currently has no one at an intermediate technician level. Some lower level staff such as guards and labourers, have been adapted to perform activities related to interpretation and so to help research and data collection work. However, they have not been assigned into these new categories, because there is no such official position to be occupied in the parks (for example visitor guide, interpreter, guard-park guards or research assistant). As there is no career prospect in their position, there is no change in their salaries and therefore little encouragement. It would not be so difficult to train some of the best low level staff to deal with, for instance, basic GIS tools, but certainly it would be difficult to keep them in the job when they can only earn salaries related to lower level positions such as guard or labourer.

There are a few current staff members with potential for more specialised or skilled work (and presently carrying on such functions). These people are not satisfied with doing these more specialised activities whilst receiving the same salaries as the less skilled workers. As they are a very few in number, such people end up with a heavy work load. From less skilled workers (guards) to office clerks, personnel complained of the salaries and were engaged in other small jobs in their free time to improve their wages. One of the

[8]Unlike PEMD which does not have any illiterate workers, 17% of the PECJ work force is illiterate. This may be related to the fact PEMD has a higher number of young staff than PECJ does. Most of PEMD staff were contracted in the mid 1980s and those of PECJ in the early 1960s.

staff who was being asked to undertake education and interpretation tasks, and also to help in ecological data collection for an IF research project, clearly mentioned his dissatisfaction with this situation, with which the other interviewee guard agreed:-

> *'I am performing a skilled job, which is interesting, but unfortunately there is no earning improvement. I am receiving a salary as that of guard, for which I was contracted.'* (1992)

Furthermore, researchers of Research Institutes including IF, who can overlap responsibilities such as management and research, are earning less than University researchers who have already suffered salary losses (see Chapter 5) . In the case of IF, the researchers are asked to overlap responsibilities such as management of park and research functions.

The example of personnel contracted for less skilled tasks, but developing functions of middle-level technicians, also appears in the file of personnel of the park, which is partially transcribed below (Table 7.3).

Table 7.3- Data about personnel performing middle-level tasks.

Item	Name	Position	Function	Agency	Background
____	_____	Guard	Research Auxiliary	IF	High school
____	_____	Labourer	Meteorological observer	IF	Primary School
____	_____	Guard	Research auxiliary	IF	Biology student
____	_____	Labourer	Meteorological observer	IF	Primary school

Source: This table was organised based on data provided by Robin (1992).

Therefore, the middle level technical work is basically carried out by few people who are contracted as lower level staff. It is generally agreed that this is a situation which discourages development of the park service. Additionally, 86% of the staff are about to retire[9]. For example, about 70% of guards are 50 years old and are about to retire[10]. None of them have been trained to perform such a task. All of them have only basic school

[9] Information calculated from data collected by Robim (1992).

[10] The date of retirement is defined by length of service in work rather than age. In Brazil workers are expected to retire after 35 years. Usually people retire from their early to mid-50s.

background. Presently the state government institutions are prohibited from hiring further staff in order to reduce expenses (since 1984)[11]. This represents serious management problems.

The staffing levels of State Park of Campos do Jordão outnumber those of any other park of the Forestry Institute-IF. This is a direct consequence of the planted forest programme. However, if the other areas have problems of inadequate or reduced numbers of staff for very basic activities of protection such as guard duties, Campos do Jordão shows that the staff problems not only refer to quantity but to quality. The park structure and functioning show how necessary it is to have a strong middle technician level, with co-ordination of programmes under high level technicians and adequate salaries. This precarious situation makes it difficult to establish more sophisticated and expensive management tools such as GIS.

The loss of specialised staff to private companies which pay better, is not an uncommon occurrence in the context of government research centres. In the case of PECJ, there is one member of staff working in administrative functions, though contracted to the position of guard, who started taking a course in computing. He has therefore acquired an initial familiarity with computers, and could be trained to use database management systems. However, because of the low position occupied and also the low salary it is likely to be very difficult to keep this member of staff in future, even if he is trained to manipulate and use information system technology. Training, may, in fact, make his skills more valuable elsewhere. Furthermore, lack of training on a regular basis is a problem throughout the Division of State Reserves and Parks (see DRPE-IF, 1992).

An alternative that has been used in the park is to utilise university student trainees, despite its short term appeal and dependence on external payment (such FUNDAP-case of PEMD). This is a very temporary solution, because the trainees only work for the project during vacation time. An example was the *Cachoeira* trail project which was funded by

[11] The staff who were hired temporarily by FF was laid off after change of State Government in 1995.

WWF. But this is not a stable kind of funding and a park cannot depend upon short term contacts. Furthermore training students does not benefit the park as they stay for only temporary periods. In the case of FUNDAP, a fellowship is offered only once to student and there is no policy of further offers (the same case of PEMD). Another example is the regeneration project of the *Morro do Elefante* in the neighbourhood, supervised by the park manager. These projects have been using student assistance for the collection of plants. Therefore, a student "solution" is quite difficult because they have to combine college time and training. This also depends on the University's distance from the area. Therefore this cannot represent a permanent solution for human resources.

Because there is a lack of skilled staff for park management needs, the manager has to be responsible for many functions which should be done by other middle level technical staff. In the special case of PECJ, this also includes the administration of the planted forest project. There is a severe problem as the manager is overburdened [12]:-

> *'Because of the lack of adequate human resources and mainly because we are overlapping responsibilities of administration, research and environmental education, and also co-ordinating, we are facing difficulties in managing the planted forest areas, which require to be evaluated in order to ensure adequate planning'.* (1991)

Thus, the human resource situation is the key problem of park management. The manager outlined the problems such as the lack of a technician to co-ordinate the utilisation and studies of the reforested area, and to monitor the regeneration process. Furthermore there is the need for transport (e.g. motorcycle), and the lack of budget for the maintenance of road equipment.

Instability and centralisation of the budget are also problems which give uncertainty to the managers work. The manager stresses:-

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[12] Information obtained by official letter sent out by the manager of the State Park of Campos do Jordão, Ms. Maria de Jesus Robim, to the Director of DRPE/IF in 4th of october 1991.

'Every year, each park manager develops a plan of activities for her or his area. The budget planned is included in the general budget planning of Forestry Institute which is sent to the Finance Secretary (Secretaria da Fazenda). It is usually subject to reductions. In fact, every year we do not know how much we are going to have. We ask for the resources to develop what has been planned, but most of time we do not receive the necessary finance to achieve what was initially agreed.' (1992)

The manager has to negotiate continuously for the meagre resources in the central agency, in order to develop what has been planned. The manager points out that it is very stressful to be in this constant negotiation with the central agency to get the proper financial resources for the area, which often is unsuccessful. For instance, the manager has been asking for money for building a restaurant, which was proposed in the management plan 20 years ago, but no funding was allocated for that so far. Additionally, the management plan also contains a proposal to enlarge the park area 480 ha. in the Northwest and along Southeast (see Figure 7.3). Financial resources were never made available in order to carry it out.

Another good example of the centralisation, is that of the fees which are charged within the park but do not stay in the park. In 1991, a total of US$ 35,112.79 was obtained from charging entrance fees[13]. The initial plan for charging the visitors contained the concept that 50% of the fees should be returned to the park, but this has never been implemented. In the state park regulations, there is an item which mentions the same point (São Paulo, 1986). The manager observes:-

'Unfortunately, the State Park of Campos do Jordão which started the fee charging system for parks, is not receiving the 50% as was initially planned. This is sent to IF fund and actually we are not receiving anything. This was decided from the top and we have to accept it.' (1992)

In 1989, it was proposed that the park should develop a plan to invest the financial resources derived from the planted forest products. A plan was produced - *Plano de aplicação dos Recursos Financeiros Gerados Pela Exploração da Floresta Plantada No Parque Estadual de Campos do Jordão/SP* - defining the priorities concerned with

[13] Information calculated from the park records (*"Notas Fiscais do Produtor"*) (1992).

investments between May and December. The financial resources were provided from the sale of logs and *'..will be applied to the park, in maintenance of existing infrastructure, in implementation of projects related to the public use, to the exploration of the planted forest and to research projects'* (see Seção de Parque Estadual de Campos do Jordão, 1989). According to manager, this plan worked reasonably for two years, but with the changes in the top manager running the Department of State Reserves and Parks-DRPE the initial agreement between park and FF was cancelled. It seems that the new administration of DRPE decided that this park is not a priority and therefore does not require this resource. Furthermore, the financial resource derived from the selling of plants (from the tree nursery) also does not stay in the park. There is therefore, no means of improving locally the finances to support current and future developments in the park. The financial resources for parks depend mainly on availability of funding from central agency and top level managers decisions and priorities. Furthermore it seems that there are no clear directions to give continuity to administration when there is change, relying mainly on personal characteristics and interests rather than on a planned strategy. As the manager points out reporting to the PECJ:-

> *'If the manager is more interested in the planted forest management he or she gets involved with that more than with public use management'* (1992)

Therefore the lack of commitment to the management plan and the lack of management strategies generates a type of management that is too personal.

The difficulty of a centralised and bureaucratic system affects major and minor items; even down to the level of car maintenance. Any costs which require acquisition of capital goods involve a long bureaucratic process of pricing, being negotiated with the central agency at several levels. According to the clerk and the manager this can take many months (see similar problems in previous case study in Chapter 6), and as a consequence of inflation and delays in government payments due to the bureaucratic process, private companies are not so willing to provide services for the government.

Thus, besides the problems of human and financial resource shortages, the centralised and bureaucratic administration aggravates the difficulties of park management. It is very much subject to changes in the government and of the top managers in the central agency administration. Continuity in direction is another uncertain factor. There are clear signs of a strong top-down approach, and thus a dependence on top manager decisions and caprices about resource allocation.

At present, it seems that the efforts at the state level have been directed towards implementation of infrastructure and personnel in parks which were nearly abandoned and in a more precarious situation than PECJ. An example of this is that of the coastal parks, which are large parks with very few people for protection and with serious problems of land ownership. The director of the DRPE stresses this concern:-

> *'Presently, we are very busy with the land regularisation process (preparing Judicial documentation) of the State Ecological Station of Jureia'.* (1991)

Therefore, the above description of the park organisational and institutional context provides a picture of the PECJ management bottlenecks and of potential constraints that the introduction of GIS technology could face.

7.6- Park management and information management issues

Sound park management demands a balance between use and conservation. PECJ is located in one of the most outstanding tourist areas of the State and it has been receiving many visitors (see Figure 7.1), including schools. About 6% of the visitors are students from school tours[14]. It requires careful management and planning of visitors and recreation. There are various environmental problems that the park manager has to face, such as erosion and landslides due to the planted forest exploitation aggravated by the steep relief; risk of fire due to the presence of people living inside and as a result of visitors. In 1994, the PECJ was affected by a devastating fire which took a few days to be suppressed.

[14] Data was calculated from the park records. It refers to the year 1991.

Furthermore, there is a road crossing the park which accesses another state (Minas Gerais). The existence of large areas of natural *'campo'* (natural grasslands) also increases the risk of fire. There are degraded areas due to the existence of cattle and agriculture fields (resident people and experimental fields) until the 1970s. Because there are areas of *'campos'* (natural grassland), residential areas, and high demand of visiting, the risk of fire is higher[15]. There is also the management of the planted forest. These all are management problems.

GIS can provide the database for management and monitoring of fire, management of planted forest, recreation, vegetation and habitats, environmental education and for research. First, this section will consider what data sets are required to establish policy for recreation and visitor management. Then it will focus on what data exists and how it is collected and stored. It also points out the problems of data availability for the park. This section will also identify the data requirements for the management of natural resources (e.g., vegetation).

Recreation and visitors management

The present management is focusing on the recreational and environmental education aspects, as well as on conservation. It seems that until recently the emphasis was more on the planted forest area and in the mechanisation project developed by the Japanese International Co-operation Agency Joint Project (JICA Project). At present, there are three trails opened for public use and several picnic areas within the park. Camping areas were proposed in the management plan, but these areas were not yet established. One of the reasons for not having camping is the inadequacy of human resources, the manager comments.

As Andrade et al. (1992) note, at present there is inadequate planning and implementation of trails throughout the State Parks and other protected areas in Brazil.

[15] The park was affected by a massive burning in 1994.

Existing tracks usually present erosion problems, lack of directions, lack of maps, dead-end paths, and critical security problems. Trails are important for visitor recreation and for education and interpretation programmes. Because of the high-level of visiting in the PECJ, the manager points out that the park requires to have an impact assessment of visitor use (Is the existing structure sufficient? What are the strategies to reduce the effects of use?). In the contemporary understanding of parks and protected areas, visitors use is an important characteristic of the park management.

The management plan proposed the construction of lodging facilities for visitors and camping areas which were not yet installed. The plan also proposed opening of trails for walking and horse-riding. The implementation of these areas will increase the human pressure in the park much more. At present, there are a few trails and lodging facilities, but these are for researchers only.

The recreation and visitor management requires spatial and non-spatial data. Some of these data are available whilst many others are not (see Table 7.4).

The visitor data are not collected for the three existing visitor trails. As alleged by the manager there are no personnel to do so on a systematic basis. Basic visitor data is collected at the entrance of the park, and is analysed monthly and sent to the central office (IF). The products are graphs showing the variation in the number of visitors per month and year, which is organised in the park office by a person contracted as a clerk. Data on vehicle numbers and type (private vehicles or bus), and on the origin of the visitors are also collected, but not analysed. Usually these raw data are kept in cardboard boxes in the park office. Data from visitors before 1980 were not kept. The purpose of visiting is also identified (e.g., private and educational purposes). The data organised in the park are sent to central agency. The manager observes that these data have been used, for instance, to present reports for top managers in order to show the current visiting level situation (see report presented by manager to top managers in Seção de Parque Estadual de Campos do Jordão, 1991).

Table 7.4- Data required and data available for PECJ visitor management

Required data	Available data Spatial	Available data Non-spatial
Natural Resources and Land Use		
-Vegetation	Y[1]	Partially
-Fauna	Y[2]	Partially
-Soil	N	Partially
-Relief	Y	-
-Water/ drainage	Y	-
-Zoning areas for management	Y	-
-Buildings	Y[3]	-
-Trail	Y[4]	-
Socio-economic		
-total numbers per park	-	Y
-total number per trail	-	N
-total number per picnic areas	-	N
-distance travelled and origin	-	Y[5]
-mode of transport	-	Y[6]
-age groups, profession	-	Partially[7]

[1]See more detailed information in Table 7.5. More detailed vegetation maps for the trails and picnic areas management would be required. The vegetation map is not updated. It was produced in the early 1970s.

[2] There is a general map of fauna (broad classes such as Forests Fauna, Fauna of *Campos*, Fauna of Rivers, Fauna of Marshes. A broad list of species is presented in the management plan.

Note: Although fauna observation areas (*cevas*) were proposed in the management plan, they were not opened to visitors - being only used by researchers. According to the manager, having a good management policy for these areas would demand adequate personnel.

[3] This information needs to be updated, as new buildings were constructed, and others were removed.

[4] More detailed maps of relief and soil would be required for trail management. There is a map at 1:20,000 scale with the trail system.

[5] Data about origin is collected but it is only kept in cardboard boxes.

[6] The transport is differentiated in terms of school bus and private cars. People who come by town bus are not counted.

[7] The groups are only differentiated in terms of school and general public visitors. There are no data about profession.

The interest in the automation of the visitor data collected in the parks is pointed out by the clerk in charge of the organisation for visitor data at the Central Agency:-

> *'There is interest at the central office in the automation of the visitor data, i.e. creation of a database for all parks in the central agency. The data manipulation and storage would be facilitated by the use of computers'* (1992).

A Database Management System (DBMS) would help to organise these data and facilitate access and manipulation, associated with graphic facilities and spatial data handling programs. In fact, there is already an initiative towards the use of simple database

management systems such as DBase, in the central agency. The first stage involved the development of an administrative information system for the parks under IF administration based on DBase III and available at the Division of State Reserves and Parks (DRPE). According to the system analyst based in the central agency and responsible for the project implementation, the next steps include the development of a database for visiting and ecotourism in the parks. This project is a centralised database management system. The system analyst involved does not have experience of GIS techniques or of spatial data handling software.

PECJ is essentially a park for recreation, with a long tradition of receiving visitors. It has a high demand for visiting and recreation, particularly because of its location in a traditional and well known tourist town. It is also located in one of the most populated areas of the State, not far from São Paulo city, which provides the most significant number of users[16]. The study, implementation, management and monitoring of trails and visiting areas are therefore essential activities for this park.

During the field research for the present thesis, the manager in the PECJ initiated a project for trail system analysis in the park, which involved landscape analysis and a method of assessing land suitability for trails based on scores. This project was developed by two researchers from the central agency together with the park manager. The data manipulation and analysis was done in the central agency using manual methods. The work involved manipulation and re-drawing of many maps, overlay analysis and the use of score criteria for the evaluation of landscape and for trail network planning. When asked if they had any idea of how GIS could contribute to this kind of work, the replies of the staff involved indicated they did not have a clear idea about the nature of GIS and they could not therefore say what it could do in terms of analysis. This is an important point as regard the acquisition of a system. The potential users should understand what the system

[16] Information provided by the park manager (1992).

to be acquired can do; even if they do not have experience they should at least know the conceptual basis of the potentially useful methods provided by a GIS.

This project updated the map of trails at a scale 1: 20,000. However, the most recent source of information used was aerial photographs taken in 1981. The trails opened after this data were plotted using very *ad hoc* methods (compass and metric tape), which is not geometrically very accurate, particularly in steep areas. Thus, in developing and assessing a project such as this the sources of data should be carefully analysed in order to know the quality of data. This is an important step in establishing a good database.

Natural resource management

The park management involves the management of natural resources such as vegetation and fauna. The management plan proposed the progressive restoration of the planted forest area (it was proposed to introduce selective felling of the forest in about 30-40 years, with induced restoration of natural species), the elimination of weeds (areas of *Croton urucarana* and *Chusquea* sp), the progressive elimination of grazing and agriculture and the restoration of these areas. According to the manager and IF researcher, grazing was already eliminated and there is a need to study and monitor the regeneration. So far, there has not been any induced regeneration. In order to carry out the latter tasks, spatial and non-spatial data are required. Table 7.5 presents what is required and what is available.

It is necessary to have permanent ecological studies in the areas which were defined to be restored, for example, the planted forest and the areas which used to have grazing and agriculture, and in the areas invaded by weeds. After 20 years of the management plan, it is necessary to assess what is happening in these areas in order to guide and evaluate management actions.

Table 7.5- Data required and available for the management of vegetation in the PECJ

Required data	**Available data Spatial**	**Available data Non-spatial**
Vegetation (including restoration and burned areas)	Y[1]	Partially
Soil	N[2]	Partially
Relief	Y	-
Trails	Y[3]	-
Zoning areas	Y[4]	-
Drainage	Y	-

[1] The vegetation map was produced for the management plan using aerial photographs 1:25,000 from 1971-1973.Therefore it is outdated. Although the vegetation of the State was mapped in 1989/90 by the project OLHO VERDE, by using satellite image, the classes are too broad (see Table 1.1, in Chapter 1). It is also necessary to have larger scale maps of the areas for restoration. As Table 7.6 shows, there is a topographic map 1:10,000 which could serve as basis for a more detailed vegetation map of these areas. There is already information of the boundaries of the planted forest type plotted in the map 1: 10,000.
PS: Data such as a burned area could be extracted from digital image processing by the team of the project OLHO VERDE[17], in DEPRN, which is part of the environmental sector of the State.However, the shortage of qualified personnel and equipment are jeopardising the project continuity. Greater resource capacity is required to create and manage a large database for the whole State. There are only two PCs 286 (40 Mb and 80 Mb) to manipulate the data for the entire State (the project will have to supply information about deforestation of 21 regions in the interior of the State). The co-ordinator of the project (1992), stresses that this project can only be in full operation when the computer capabilities and manpower are improved.
[2] Map of the soil type distribution is not available, only the plots of samples for some areas of the park. According to the management plan it is necessary to improve the soil studies which were started and it should be done for all of the park. The soil samples studied are mainly concentrated in the areas of planted forest (map in the management plan shows this pattern). Soil studies and records were published by Oliveira et al. (1975).
[3] There is an updated map at scale 1:20,000 which contains all trails (administrative and recreation trails).
[4] There are three main zones, the classification was based on recommendations of Second World Conference of National Parks (see Seibert et al., 1975): zone of intensive recreation, zone of extensive recreation and zone of 'silence' (*zona de silêncio*). Clearly, they are extremely simplified and basic zoning proposals. Therefore, the park zoning system needs to be reviewed. In 1986, the law which established the regulation for the state parks proposed a zoning system which contained seven classes, including a zone of regeneration (São Paulo, 1986).

The elaboration of the management plan involved the establishment and compilation of the resources baseline data by the IF and University of Munich. The information included maps of vegetation, land use and zoning, soil studies, and lists of species of flora and fauna. The substantial part of the available natural resources data were collected during the production of the management plan. During September 1973, Dr. Paul Seibert (lecturer at the University of Munich and head of the Division of Studies of the Vegetation and Conservation of Nature - Organisation of Forestry Researches of Bavaria) developed the Seminar Landscape Management and Vegetation Mapping: State Park of

[17] This project is briefly explained in Chapter 5.

Campos do Jordão (*"Seminário - Manejo da Paisagem e Mapeamento da Vegetação: P. E. de Campos do Jordão"*)[18]. This seminar resulted in the management plan (Seibert et al., 1975) and in the Atlas which contains the vegetation map, which has not been updated since then. The available spatial data are shown in Table 7.6.

The management plan provided a better knowledge of the park resources; nevertheless, the information has not been upgraded and updated since then. Management of vegetation and land use requires updated and more maps in more critical areas, such as, the degraded areas or along the trails. There is no map or study on the density of mammals in the area. Soil data available for specific sites (e.g., types, depth and texture) (see published paper by Oliveira et al., 1975). However, there is not a map of soil distribution in the park. Although there is a Hydrometeorological Station inside the park (belonging to the State Department of Water and Electrical Energy- DAEE) there is no study of micro climate. Additionally, as the manager notes:-

> *'There are very few and scattered studies on fauna and flora in the park. Many aspects of research need to be amplified in order to improve the basic ecological knowledge particularly in terms of the relationship between bio-physical parameters. The data about fauna produced in the plan was more reconnaissance in nature, with lists of species. Now we need more detailed information. We need to improve the existing information (.....) It is also necessary to define research priority in the park'.* (1992)

This is evident from an analysis of the management plan, and of what was produced after that to improve the information base. Seibert et al. state in the management plan:-

> *'The botanical researches were started with a survey of flora and identification. It should evolve to a systematised collection. The sampling plots will be implemented within the physiognomic units already mapped and the survey of flora will follow the method Braun Blanquet (1964). These plots for collection of botanical material will be visited every year.'* (1975, p. 118).

[18] See publication by Seibert (1973).

Table 7.6- Available spatial data, data sources and location for the PECJ [19].

Type (paper)	Scale	Year	Source	Sheets	Location
MAP					
Topographic	1:50,000	1971[1]	IBGE	2	Park office and Central Agency
Topographic	1:10,000	1977/78	Terrafoto[2]	13	- same as above -
Thematic:-	1:35,000	1975	IF/University of Munich (Management Plan Atlas)		- same as above -
-Soil samples				1	
-Vegetation types				1	
-Vegetation region	-same as above-	-same as above-		1	
-Geology				1	
-Slope				1	
-Zones of use				1	
-View points				1	
-Socio-economic				1	
-General fauna				1	
-Grazing level				1	
AERIAL PHOTOGRAPH					
	1: 25,000	1962	IGG		IF- Central Ag.
	1: 25,000	1971-73	Terrafoto		- same as above -
	1: 45,000	1977	Terrafoto		
SATELLITE IMAGE					
	1: 50,000	1991	INPE	1-colour	IF- Central Ag.
	1:100,000	1991	INPE	1-B&W	- same as above -

[1] There are two sheets. In 1984, one of them (Sheet-Campos do Jordão) was published again using Datum SAD-69, the other (Sheet-Delfim Moreira) one adopted Datum Córrego Alegre, MG. Therefore, there are some matching problems between them, requiring a system transformation when these are digitised. Furthermore, both were produced using aerial photographs from 1965 (American Air Force).

[2] An airphotogrammetric survey company based on a mix of private and state capital. It no longer exists. This topographic mapping was demanded by the State Secretary of Planning.

So far these permanent plots have not been implemented within the mapped physiognomic units.[20] There are no phytosociological studies on a continuous basis. These studies are important to understand and to monitor, over the long-term, the dynamics of the vegetation succession and therefore to define strategies of management. Seibert et al.

[19] The spatial information is only available in paper format.

[20] Information confirmed by the current manager (1992).

(1975), in the management plan, goes further in suggesting continuity of research and in-depth studies of vegetation:-

> *'The studies of vegetation should be improved with a base in the vegetation map, and supported by botanical survey. This should correlate vegetation units with other factors such as climate, geology, relief and soil'.* (1975, p. 118)

However, these studies have not been completed and carried out on a systematic basis as proposed initially. By analysing the published material available for the park (in the IF publications, other specialised publications, references in the publications and park archive), apart from the results of the management plan, it was found that there have been only a few scattered ecological studies since the plan publication. They included two projects developed by the current manager, and fauna studies seems to have fared worst (see Barbosa, 1982; 1988; Emmerich, 1980-MSc thesis; Chyo et al., 1982; Willis and Oniki, 1981; Robim and Pfeifer, 1989; Robim et al., 1990). However, it is necessary to establish studies and permanent samples in areas of management interest over short and middle time periods. A few other ecological researches are being carried out, one by USP- and other by USP- both about bees (Seção de Parque Estadual de Campos do Jordão, 1991).

Lists of fauna (mammals, birds, snakes, etc.) were published in the management plan (Seibert et al., 1975), by general classes of vegetation formation (forest, grassland and marshland). There are no large mammals in the area. According to the list published by Sick (1972, in Barbosa, 1988), the park provides a habitat for bird species threatened by extinction. Barbosa (1988), in his study on birds of the State Park of Campos do Jordão (the only one) found that species such as *Sicalis flaveola brasiliensis* and *Gnorimopsar chopi chopi* has disappeared from the area, and that *Tinamus solitarius* is represented only by few individuals. He notes that the park is one of the last refuge for species such as *Amazonas solitarius*. He also points out that there has been significant reduction in the

number of bird species in the reforested area within the park, registering their occurrence only at its edge. Clearly, it is important to have an adequate knowledge about the fauna inhabiting this area in order to manage it properly. This kind of study should be carried out on a continuous basis in order to monitor what is happening in the area and also to identify management strategies and to appraise the efficacy of management actions.

The knowledge of fauna is virtually limited to the first list of species produced for the management plan, apart the more detailed study of birds by Barbosa (1988), and some few studies on bees by Department of Ecology of USP (see list of present research in Seção de Parque Estadual de Campos do Jordão, 1991). This is a critical problem for the management of parks in the State in general. As a researcher of DRPE notes, management of fauna demands a reasonable level of basic and specific information on their dynamics in order to undertake its appropriate management; and he adds that the IF has not the multidisciplinarity nor enough personnel to undertake the required fauna studies in the protected areas under IF administration. For example, there are only two IF researchers studying birds for all protected areas under IF administration.

Seibert et al. (1975), in the management plan, emphasises the importance of ecological and integrated studies for the management of the area:-

> *'In relation to the biotic factors, a broad range of specific studies is required in vegetation, fauna, and the modifications on the environment caused by the man's action, and their relationship. The fauna are conditional on the types of vegetation. In turn, the fauna influence pollination by insects, dissemination of seed, etc. Furthermore, the study of population dynamics of the fauna will establish the food chain in the different habitats, and their behaviour (control of population, migration, etc.)'* (1975, p. 119)

Although the plan proposed the continuity and deepening of ecological studies, by looking at the relationship between abiotic, biotic and cultural factors, the present level of ecological knowledge still lags behind planning requirements. Shortage of skilled human resources is pointed out as the main problem. The researchers and managers (both parks) agree that there are not enough skilled personnel in the IF to cope with the study of the

high biodiversity contained in the parks under its administration. Therefore, parks require to strengthen co-operation with universities and other research centres to improve information about resources.

The management plan pointed out the need to regenerate the Park areas which were reforested in the late 1950s. The planted forests were used to undertake experimental studies in production aspects, which *sensu stricto*, should not be developed in a park area but in experimental stations. The management plan suggested selective cutting to eliminate the planted forest. However, the manager and a researcher of DRPE observe that the planted forest was not well managed or monitored. The manager also notes that private companies contracted to do the selective cutting of the planted forest in the late 1980s, opened trails without taking in consideration conservation criteria; as a result the area has been subject to degradation such as erosion. This is particularly serious in areas such as this with very steep relief. The manager is concerned with the present level of degradation and the risks of worsening erosion, and points out the management problems:-

> *'There are many companies exploiting the reforested area, who are only interested in rapidly cutting the trees. They have opened up many tracks, and used inappropriate selective cutting methods.'* (1992)

The manager emphasises that a study of what is happening in terms of regeneration and the impacts of the inadequate management on the cutting is required. The knowledge of what is happening is much more a result of 'informal' information, i.e., the manager is observing what is going on, rather than following a clear plan of exploitation and regeneration. The manager points out that there is an urgent need to develop studies on the planted forest area and the regeneration process, and observes the need for an appropriate plan for this area regeneration. Thus, although the regeneration of the planted forest area was proposed, a plan and an adequate monitoring of the process of cutting and regeneration is lacking.

However, the unstable and meagre budget and lack of skilled human resources are seen as an outstanding constraint for the implementation of a system such as this. Although

the manager does not have any experience with GIS's or spatial data handling systems, and had only heard superficially about that in a conference, she points out some perceived potential benefits and problems related to the human resources and budget:

> *'Manual methods are slow, and this poses difficulties in sorting solutions for the many problems existing in the area, which are urgent. However, I think that the problem is that in order to implement such a system it is necessary to have skilled personnel and to have stable financial resources for the system's maintenance and operation, without interruptions. And an irregular budget is a problem in our organisation.'* (1992)

Therefore, the park manager does perceive that geographic information systems have the potential to improve the manipulation of geographical data in the context of park planning and management. However, the manager is sceptical concerning the park's organisational capacity to operate such systems due to the budget and human resource constraints. The park manager had a similar view to that of the PEMD manager, that a simple PC with a wordprocessor and a simple software package for making tables and graphs would be a much more useful way to start the use of information technology in the park. The staff member (a clerk) who is in charge of organising data records on visitors and human resources in the park, did not know what a GIS was, but he also mentioned the relevance of having at least a PC with the same software available in the central agency (DBase) and in the park area as well to make his job more efficient.

The park manager and key informant researchers did know about the capacity of GIS to carry out the kind of analysis discussed in the context of the trail project on pages 178, but they are aware of GIS as being a kind of computer based mapping system. As in the PEMD case the PECJ manager is sceptical of introducing it in the context of the park management at present.

All the activities related with design and production of maps are carried out in the central agency, which has a reproduction section. The air photographs are located in the central agency archive. There is no equipment and specifically trained personnel to perform spatial data handling in the park office at present. This component of

centralisation in information management can be seen in the example of the trail project above described, where the production of maps and the results of the overlay analysis were carried out in the central agency. Even a photocopy machine is not available in the park.

The park does not have any equipment for surveying, measuring and recording survey data, including basic topographic survey - as tape measure, levelling and planimeter (see list of materials and equipment of PECJ in Robim, 1992). As an example, only recently it acquired a compass for the trail project, which was funded by WWF. During the time of the present fieldwork it was observed that even to open and locate a new trail, ad hoc methods were adopted (simply compass and metric tape) with one member of staff and equipment provided by the central agency plus two students. Furthermore, even equipment such as a slide projector, camera, binoculars, video and television were donations of JICA and more recently of the WWF and were not a part of a regular investment by the State Park Agency.

Obviously, it is not only equipment that is required, but people to carry out the necessary work on a continuous basis. A first study of bird fauna was achieved by a researcher (Barbosa, 1988) of the central agency but a continuity of his study would be highly desirable to enable more informed management.

One of the root problems is shortage of qualified staff, as IF does not have the necessary personnel to develop systematic ecological research within the parks. The Manager notes:-

> *'It is not possible to develop all activities of management and research alone, without support from qualified people on a day-by-day basis'* (1992)

Furthermore, it is argued, what is the point of applying sophisticated models and systems for wildlife management and prediction if there is no data and/or no personnel to collect them on a continuous basis, i.e., monitor what is occurring. There are scattered ecological research lacks integration, continuation and practical applications for

management. For example, how can the research results about birds be used? Can something be done to improve the reproduction of bird species in which were noted as being reduced in population? If so, are the re-introductions being successful? This will demand a monitoring programme in the area.

Furthermore, it is important to have those data in a framework that could be used by management. This could involve greater integration of what has been done, to avoid having simply bits and pieces of data without connection. It is argued here that a simple unified information system, would greatly aid the cross referencing of disparate data and provide a comprehensive data base for management.

An information system such GIS and DBMS could improve this integration and co-ordination of existing data, particularly resulting from research. Nevertheless discontinuities in plan implementation associated with lack of adequate resources are great impediments to effective management of the park. The difficulties are increased if the adoption of sophisticated and expensive technology such as GIS is to be pursued. Furthermore, as conservation depends upon information about the resource conditions and on monitoring, GIS is a tool to support a more planned and scientific-based management than exists at present.

7.7 - Discussion

Firstly, the discussion will consider what problems may hinder the introduction and use of GIS technology in the PECJ. The outstanding issues are related to human resources, funding, availability and continuity of adequate programmes for park management. Secondly, the ways by which GIS could be introduced given these issues, will be evaluated.

- **Assessment of park organisation and institutional context**

Human resources

The fact that PECJ was used to test planted forest with exotic and other studies related to production forests, favoured the creation of infrastructure and the contracting of personnel. However, the personnel, although numerically large, are composed mostly of unskilled and underpaid staff who have been contracted specifically to work on the planted forest project. Most of these staff members are near to retirement. As IUCN (1986) notes, managers of tropical developing countries rarely have a team which includes specialists in the various appropriate fields of management (planners, interpreters and so on) analogous to the well-developed and intensively managed parks of temperate countries. Therefore, inadequacy of human resources is the one of the most critical problems for the management of PECJ, as Machlis and Neumann (1987) found for the parks in the neotropics and Amend and Amend (1992) found for the parks in South America.

Even if a number of staff are trained for more specialised jobs, it may not be successful for park management, because earnings do not encourage such people to go beyond their less skilled functions. It may be more advantageous for them to have second jobs, instead of being dedicated solely to the park. For staff who already have some skills which could be developed and/or have the ability to benefit from full training (e.g. for computer tasks), it is probable that such training would place them in a better position for looking elsewhere for new attractive jobs. Shortage of skilled park staff causes deviation of functions, which is shown to be a critical problem for park management. Additionally, even researchers, amongst which park managers are included, receive low salaries compared to Universities and have to overlap functions. In other words, they have to develop research and be administrators of these areas as well. This is not an encouraging situation for the development and improvement of park management.

As in PEMD, the PECJ situation analysed above shows the incidental and unstable nature of the resources for management. Furthermore, the existence of a management plan

is not a guarantee of continuity of proposed actions and researches. Commitment to plan continuity and with improvements in human resources, through regular training, re-training and possibility of career and salary improvements (as well as more co-ordination and co-operation with universities), are essential ingredients for a well implemented park plan. This is particularly necessary when involving sophisticated information technology such as GIS. There is no doubt that the general situation of state park system is better than in the past, and although constrained by human resources in particular, attempts have been made to organise a genuine park system.

Funding Issues

The funding situation is limited to a meagre government budget and very dependent on top managers decisions and priorities. PECJ, for example, has a reasonable visitor demand and it was the first park to charge an entrance fee; however, due to centralisation this income is not invested in the park. Furthermore, there has been little investment in studies and monitoring of the park ecological resources. So far, what significant international investment there has been in the area (as provided by JICA) was directed towards the planted forest interest. As Curtis (1993) points out, the shortage of public funds for long-term operation and maintenance of protected areas is a critical problem, particularly for training, research, interpretation and education. The significant international funds, when available, provided by organisations such as WB and KfW, have been allocated only for the coastal state parks which were nearly abandoned and were totally lacking in basic infrastructure such as buildings and equipment for management.

Thus, although there has generally been improvement in the state protected areas system, yet lack of stable financing and particularly human resource bottlenecks are outstanding barriers to the adequate and successful management of these areas.

Data issues

Although spatial data such as vegetation and land use (buildings, etc.) need to be updated, the fundamental structure already exists, for instance all the maps produced for the park are on a standard map projection system UTM (Universal Transverse Mercator) which is adopted in the country by IBGE and DSG (organisations responsible for the topographic map series in Brazil). However, these topographic maps have never been updated, and were produced from aerial photographs from mid 1960s. The two map sheets are in a different ellipsoid system. Furthermore, the topographic map series are not yet available in digital format.

The vegetation map was produced by a reliable team, involving the University of Munich and personnel from IF. The latter has long experience in interpretation of aerial photographs, being responsible for the mapping of the natural vegetation and the planted forest of the entire State (in 1975), and more recently by using a satellite image (visual interpretation) together with the staff of DEPRN in the project OLHO VERDE (see chapter 5). There are potential sources of digital satellite data, such as the project OLHO VERDE, which could be accessed by the park. However, it will depend upon firstly, the strength of co-operation among these two agencies, which are part of the environmental sector of the State (see Figure 5.1 in chapter 5), and a degree of parochialism may hinder the use of such data source. Secondly, this project is not yet fully in operation and lacks adequate personnel and equipment for the amount of work which is required. It is difficult, therefore, for the project team to provide information for other users than the surveillance personnel. Furthermore, they work with a more general set of vegetation categories (*forest, cleared land*, etc.) rather than with more detailed vegetation data at the level of communities. In addition management of the park's resources really needs make detailed studies of species on a dynamic basis.

It also requires the improvement of information about soil, which has not yet been mapped and of data being made available for sites within the park.

The knowledge about fauna is still very limited, apart from the studies about birds by Barbosa (1988), which focused on management problems such as the re-introduction of species. However, it is necessary to know the fauna on a dynamic basis, i.e., what is happening over time, and no programme exists to monitor fauna (e.g., the different types of mammal or key animals) on a continuous basis. Additionally, personnel and funds are most urgently required to carry it out. Adequate funds and shortage of qualified personnel are a further problem.

Infrastructure and equipment

The park possesses a reasonable infrastructure for operation, administration and recreation. There are adequate buildings with electricity and telephone. There is a lodging facility for researchers. Furthermore, this park is near São Paulo city, and close to many urban areas with good infrastructure. All access is by paved roads and the nearest town, Campos do Jordão, is about 9 km away, and provides adequate services. Therefore, the infrastructure is not an outstanding issue for the park management. Yet, resources for the construction of a restaurant were not made available. This is one of the most visited parks in the State located in the only traditional winter tourist areas of the State, so a restaurant could be useful to meet demand and at the same time could help to raise money for the park. However, the main problem is availability of funds for vehicles and equipment maintenance and operation.

Management Plan and programmes

The management plan needs to be reviewed and information upgraded (soil, fauna, plant communities, visitors). Programmes for monitoring and studying the park's natural resources (restoration, fire and its effects, water and so forth) need to be established on the ground. Additionally, the implementation of a system for evaluating management and monitoring programmes would be an important step in identifying problems and suitable

management strategies. For example, the initial work on introduction of species of birds being developed in the park requires to set up a monitoring programme in order to know what is happening. It is necessary that long-term studies be made. Therefore, a management plan cannot be a static piece of work, it needs to be reviewed and assessed, and for doing so, it is necessary to acquire updated information on the resources and be able to interpret and manipulate such data.

- **Evaluation of the constraints and potential for introducing GIS**

This section considers how the situation outlined and analysed above, constrains the introduction of GIS technology. First, an initial investment is necessary in order to purchase the appropriate hardware and software. This in itself, is a relatively minor item although maintenance and upgrading require constant inputs. Second, adequate human resources need to be available to operate and use the system. Personnel need to be motivated, well trained, well managed and paid appropriately to maintain and use the system.

Third, the budget needs to be stable and well managed if the system is to function. In the Brazilian context, as with many tropical countries, this is rare. In the case of PECJ, financial resources are erratically allocated and poorly managed. For example, money is seldom allocated for maintenance of equipment which sometimes lies idle because there is no funding to repair it or because of the long bureaucratic process, since the budget allocation is centralised. Budgets change with changes in government. There is a highly political flavour to the funding. Therefore, given that so many constraints exist in this context, it is not appropriate to start with a full GIS, even a low-cost GIS, as resources are likely to be wasted and outputs may be unreliable or underused.

The GIS technology is changing fast, and low cost alternatives such as IDRISI are evolving which perform well. Therefore, the software choice is not so straight forward. The best way to start the evaluation is to take the hardware and software together by

considering two extremes: one represented by powerful technology based on Workstations, and the other by PC GIS systems and other PC- non GIS systems.

Workstation GIS systems are too advanced for this park. Systems such as ARC/INFO and Intergraph require a high investment in technology and personnel not only to manage the system but to use it to its full capability. It is most appropriate in an environment where a high level of training and sophisticated management is practised, such as for example the Canadian Parks Service. In this example, GIS is used to support sophisticated management based on simulation and prediction modelling and therefore in testing alternatives. This involves not only expertise but database and integration with ecosystem management models. The work of Buckley et al. (1993) shows that such advanced level of management requires a much more detailed understanding of the local ecology, for example data about the density of different types of mammals. In order to have such knowledge, it is necessary to monitor the mammals, which involves availability of personnel, adequate equipment and a well-established research programme. This is far from the PECJ reality, which struggles with shortage of resources and a lack of a program for monitoring and management. There is not a well established information-based management, lacking of historic maps about fire or censuses of plants and animals for example. Most of the information dates from the initial management plan, and vital information such as plant communities and fauna studies need to be updated and upgraded. It could be said that management is still based on rule of thumb experience. Therefore, a fully-fledged GIS system is too unrealistically demanding for this context. It might perhaps be a system that could be established in the central agency, even though it is a long-term possibility given to the current situation.

Therefore it is recommended that the park should consider the adoption of a more phased set of alternatives, starting with a PC and simple DBMS, such as DBase and/or, with a software package which contains graphic capabilities, such as Lotus. Managers could quickly learn to handle and use these simple and low-cost technologies, since they

do not demand plotters and digitising tables. Furthermore, they are already available in the central agency (IF).

Another possibility to be considered is to take a more centralised approach to GIS implementation. This will be resource-saving, and can use the available software infrastructure in the central agency since DBase and AutoCAD have been acquired. Furthermore, the central agency also has a few qualified personnel including system analysts, even if such staff members do not have experience yet, with GIS. A centralised approach would better control the quality of data entry. Furthermore, PECJ is not far from the central agency. A PC with DBase could help to organise, for example, the tourist and schools data, and also the staff, thus facilitating the update of these data (required by the central agency on a 6 month basis). However, even starting a centralised approach would require skilled persons to handle GIS technology. Even if simple technology such as AutoCAD is to evolve to GIS, it is necessary to make the personnel familiarised with GIS in order to better understand the requirements and therefore help in choice and application of technology. It is also extremely important to be aware of the quality of data - sources and reliability. In the future, with the development of a networking system, a PC could be connected to the central agency. However, it is not just a matter of having a system. It is necessary to have trained personnel on the spot who know how and for what they can use the technology. Otherwise there is a risk of having an under-utilised system, even if it is simple mapping. Another important aspect is that managers should be well trained in park management issues in order to better define the requirements for information and exploration of the GIS capabilities.

By considering the introduction of GIS from the perspective of a more decentralised approach, Table 7.7 presents a more phased set of alternatives. The existence of a PC computer at a local level can help the staff and managers to familiarise themselves with information technology.

Table 7.7 - Alternative proposal for automation and GIS introduction in PECJ in a decentralised and phased approach.

Hardware	Non-GIS Software	GIS Software and peripherals
PC (286 or 386, and a printer)	Short-term (e.g., DBase and/or Lotus[1])	Middle to long-term (e.g., IDRISI and an ink jet plotter)- over 3 years.

[1] These two softwares are available in the central agency office.

This evaluation is based on criteria such as smallness (PC-based system instead of a powerful workstation), ease of use (quick to learn and good documentation), low-cost, interface to other non-GIS software (e.g. DBase), converting capabilities from vector data to raster (e.g. data from AutoCAD), good range of functions (e.g., overlay, buffer and digital image processing). Although this system works better for small areas (low-data volume), this is not a problem in the case of PECJ, which does not cover a large area. Additionally, there is an AutoCAD available in the central agency, therefore, a digital acquisition of park data could be done now and, in the future transferred to IDRISI or any other GIS software acquired by central agency or on-site. As discussed in Chapter 3, AutoCAD is a very popular package sold throughout the world. It has a standard world format (Drawing Exchange Format-DXF, type American Standard Code for Information Interchange-ASCII) for vector data export, which makes data transfer to other spatial handling systems easy. Additionally, AutoCAD software is good for capturing vector data and it can reasonably be used for mapping output. The software capabilities for capturing vector data in IDRISI are not very good.

One of the potential uses of automated spatial data handling is that PECJ could produce its folders for visitors quicker and at a cheaper price, than sending them out to be printed (e.g., offset printing). For example, a drum ink jet plotter would be good enough to produce the map output for visitors, for day-to-day operations, for educational

purposes and communication (media, schools, NGOs and other government organisations).

- **A perspective of using GIS as a tool for environmental education and planning**

As previously mentioned, PECJ is one of the four most visited areas of the state parks (DRPE-IF, 1992). Additionally it receives many schools, and people mainly from São Paulo city with a higher education level. It follows that GIS can have an important use for environmental education in this context. For example, it could use the integration facilities and DEM (Digital Elevation Model) to display views of the park landscape in order to show to students. Such an interactive Viewing System (e.g., ARC/View) can teach students cognitive aspects, such as comparison and relationship in the landscape and notions of scale. Therefore, it can help in subjects such as geography and ecology, besides that it can provide material for education about that specific environment and the importance of that specific park in the context of conservation. With the appropriate topographic data it can create a DEM with vegetation and drainage system. Park vegetation varies greatly as to topography and thus the system allows an overview of the park which can be seen from all angles and rotated from ground level to a birds-eye picture. Also it can be used to show habitats of certain species such as birds, which are at risk of extinction. One example that could be shown is the endangered *Tinamus solitarius*. It can also associate this habitat distribution to DEM and water, which can illustrate the relationship of a habitat of a specific bird with vegetation, relief and water.

In order to make meaningful use of GIS for this purpose, some requirements have to be fulfilled:-

1. Software requirements:

It will be necessary to have functions such as overlay analysis and DEM.

2. Hardware requirements:

A colour screen (VGA monitor) is required to give the best visual effect (an important visual variable) in cartographic representation, which is used to make distinction between objects of same value (Bertin, 1981). It can be a PC-based system.

3. Data requirements:

This is a very important factor. Without data this project lacks viability. This will demand minimum data on vegetation, relief and water transformed to the same scale, in order to show the relationship consistently. These data are available from the management plan at scale 1:35000.

4. Personnel:

This is the most important part of the project in the sense that it will require a well trained staff to use the system. On the other hand, a system such as ARC/View allows displays in which users do not need to know anything about GIS, and only require to retrieve the previously prepared views by a GIS specialist. This should be part of a programme of environmental education and interpretation which should have a permanent staff member and in order to be successful it requires continuity and monitoring. This could be particularly useful in PECJ. However, an expert is required to develop the application and the GIS software. Furthermore, ARC/View is not low-cost software. Therefore, all these points are related to human resources and funding. It requires commitment to conservation programmes.

Landscape analysis and land use planning are potential areas for application of GIS technology. The section of the present chapter discussing recreation and visitors management mentioned an example of spatial analysis being used to plan trail networks in PECJ which involved traditional manual methods. This could constitute a good example for the development of a pilot project to introduce GIS technology into state park planning. This manual analysis comprises essentially basic operations which could be carried by two GIS functions: overlay analysis and reclassification. Such project can allow park staff and researchers to gain familiarity and experience with GIS technology.

CHAPTER 8

Conclusions

The thesis has analysed the various constraints which could face an introduction of GIS for two state parks in São Paulo, as well as the opportunities for the establishment of GIS tools based on the principles of appropriate technology. Because of the massive institutional and organisational impediments of developing countries, this analysis has not concentrated on technical specifications, but has looked at the implementation process of information technology in a wider perspective. This has involved understanding a variety of constraints to development which are particularly problematic in the environment of countries such as Brazil, where shortage of financial and human resources is much greater than in affluent industrialised countries.

In Brazil, organisational difficulties of parks are further aggravated by the country's economic and political instabilities, such as soaring rates of inflation together with political and administrative discontinuity. The lack of commitment in previous administrations is an endemic problem of Brazilian government organisations which affects continuity of projects. Furthermore, conservation policies still have secondary importance in terms of government investment. This lack of priority results in great uncertainty in management and planning of the parks. Additionally, where management plans exist, they are not adequately implemented on-the-ground and lack revision and updating. Rigidity of the centralised bureaucracy adds further difficulties to the management of the parks at local level.

Therefore, the possibility of introducing sophisticated technology in this context, no matter how innovative, has to consider the constraints of the environment. Introduction is likely to be more successful based on an incremental approach guided by the principles of AT. Nevertheless, the results of this research have shown that

human and financial resources, data supply issues, and the availability of plans and long-term programmes for management and research are the critical problems in park management.

The **inadequacy of human resources** is one of the most pressing issues to cope with management and research needs. These involve inadequacy of salary policy and training, lack of personnel for more specialised functions and inadequate career structure for the parks personnel.

The **government budget** for the state parks is limited. Research findings suggest that funding for the implementation and management of these areas is over-dependent upon incidental or randomly-acquired resources. Therefore, funding could be a critical problem for GIS or technology introduction. The prices for microcomputer based systems are falling, but nevertheless GIS requires fairly constant maintenance and considerable set-up costs. Adding a level of further technology will put more demands on the budget. Present funds are barely sufficient, even for the very basic operational needs of parks.

The financial dilemma underpinning the implementation and expansion of a system such as GIS could be partially resolved by phased development, but this is also subject to the uncertainties of economic, political and administrative instability. Such uncertainties can cause enormous disruption in the decision-making context of the government organisations.

International funding could be used to buy the system, but training, system and database maintenance are central bottlenecks. Furthermore, international funding for environmental purposes is not so straight-forward. It is also subject to the central agency decisions and priorities and to the same long and rigid bureaucratic procedures as the government budget.

Data availability is a vital support for the information management process of park management. Although there are good base resource maps for both case studies, there is little ecological and environmental data, particularly collected on a

continuous basis. This problem is also related to inadequate human resource such as shortage of trained personnel and lack of a closer and more systematic co-operation with research centres and universities.

An improved information system is one of the set of management tools which is required to undertake sound management. The lack of a **management plan** or plan revision, establishment and continuity of management **programmes** for the parks in São Paulo State, it is still a concerning problem. Thus even the use of a low-end and low-cost technology risks failure if there is no commitment with conservation plans and programmes.

Thus, a full GIS, as 'parachuted' it were into the area, is completely unrealistic at the moment. There is no experience of automated methods of data handling in these areas and the limitations have been highlighted. Obviously, a GIS has the flexibility for building and improving long term data input into a database; however data availability is the crucial issue. Even the most simple GIS demands set up costs and maintenance of hardware, training and/or contract staff.

This research has acknowledged that there is no unique approach to GIS implementation. Moreover the principles of what is commonly termed 'appropriate technology' offer a more comprehensive and achievable framework to deal with the issues of technology choice and implementation, in the constrained circumstances currently existing in São Paulo state parks. The principles of AT are smallness of scale and simplicity of operation for resource-saving; they are considered as essential to the introduction of GIS technology on the organisational context where resources are scarce.

The strength of this research is embodied in the recognition of the need for careful analysis of the institutional environment and its constraints. This thesis goes further in suggesting flexible strategies in the introduction of GIS tools for the state parks in São Paulo State. Therefore, given that so many constraints exist it is not

appropriate to start with a full GIS, even low-cost or low-end GIS tools, as resources are likely to be wasted and outputs may be underused or unreliable.

The lack of resources associated with the history of political-administrative discontinuities together with lack of GIS experience, recommend a careful and incremental implementation of technology. Lack of familiarity with technological methods and requirements can hamper the choice of the appropriate technology. Knowledge about the availability of different types of technology is one of the factors influencing choice, even if the choice is a simple system. Furthermore, because decisions are highly political and personalised, choice may be based on non-technical and possible non-rational decisions.

Self-reliance is one of the important points that the appropriate technology movement generates. The investment of government in the development of GIS technology is still marginal. Therefore, it is suggested that greater investment in GIS research and in its applications for conservation, is required within the Brazilian research centres and universities. Low-cost GIS alternatives are evolving, but are still being developed and improved in the laboratories of developed countries. Furthermore, costs of all systems are decreasing rapidly. It may therefore be expedient and more economic to wait until costs meet a more favorable moment in government policy whilst at the same time concentrating on the basics- the acquisition of reliable resource data and the qualification of human resources.

Without commitment towards a conservation policy and a strength of public environmental awareness, any proposal for improving information management, will be difficult to advance. Information is an important tool for decision making and conservation management but its value and use will depend upon the 'actors'. Government commitment, the strength of non-governmental agencies and society awareness are tremendously important for the achievement of conservation objectives. It is recognised that the state park system has generally witnessed some improvement in the last 10 years, due more to national and international environmental movements

and due to efforts of conservationist lobbies within the parks organisation rather than to government commitment, but much should be done for the reinforcement of such progress. The strength of democracy and public participation in the decision-making process in Brazil are extremely necessary to improve conservation management and planning.

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Apendix 4.1- Managers interview Schedule.

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1. What is your background? (Academic/ work experience)

2. How long have you been a manager?

3. Did you have any previous experience of park management before working in this park?

4. Does a management plan exist for the park?

    a. When was it compiled?
    b. Has it been implemented?

5. How is the park personnel hierarchy organised? (Who does what?)

6. How satisfactory is the present staff situation in coping with the park management tasks?

7. What is the present physical structure of the park? (Building, infrastructure)

8. How is the park funded? (sources)

9. What are the main management problems in the park?

10. About information on the park resources:

    a. Are there inventories? Scientific publications? Maps?
    b. Which organizations provided the available data on resources?
    c. Are there any research programmes/projects presently in development? Which organizations are developing them?
    d. Is there any type of resources monitoring? (Fauna, Vegetation, etc.)

11. About information on the park usage:

    a. Are there any data on park visiting?
    b. How are the data analysed and stored?
    c. What are the data used for?

12. Are there any staff members with computer experience?

13. Are there computer facilities? If so how are they used?

14. What do you know about spatial handling systems such as GIS?

Appendix 4.2 - Other key-informants interview schedule: examples of the type of questions used.

Top manager:-

1. What are the main priorities in the DRPE?
2. What do you think are the major concerns about park management?
3. How has international funding been allocated among parks?
4. What do you think about the introduction of information systems such as GIS?

Staff member of the agreement IF/KfW:-

1. Which are the priority areas that will receive KfW funding?
2. Why?
3. Can you describe the process of receiving international fund?

Researchers (from IF and other organisations) :-

1. What project are you involved in or developed in the park? Which organisation funded it?
2. Does it involve long-term monitoring?
3. Do you use maps? Which maps? What for? Do you geo-reference sample plots or your data (if it is the case)? What do you know about GIS or spatial data handling systems?

Key-park staff members:-

1. What is your educational background?
2. What is your current function ?

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3. Were you contracted to perform this function?

4. What other tasks have you been performing?

5. Have you been trained for that? Type of training?

System analysts (DRPE):-

1. Which information system technology are you familiar with?

2. What hardware and software are available in this Division?

Project OLHO VERDE staff:-

1. What is this project about?

2. Which organisations are involved?

3. How has it been funded?